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UNILATERAL EXOPHTHALMOS IN INTRACRANIAL TUMORS WITH SPECIAL REFERENCE TO ITS OCCURRENCE IN THE MENINGIOMATA[1]

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IT is well known that protrusion of *both* eyeballs occurs in tumors and inflammatory processes in the orbital cavities, in exophthalmic goiter, and in increase of intracranial pressure due to chronic hydrocephalus, neoplastic inflammatory or vascular lesions within the cranial cavity, and in a number of other pathological conditions.

Unilateral exophthalmos occurs in new-growths and inflammatory processes in one orbit, in paralyses of the ocular muscles of one side, and in affections of the large intracranial blood vessels—including arterial and arterio-venous angiomata, thrombosis of the cavernous sinus, and aneurismal communications between the internal carotid artery and the cavernous sinus (pulsating exophthalmos).

In this report we shall limit ourselves to the consideration of a series of cases in which a *unilateral* exophthalmos was caused by a new-growth within the cranial cavity, and in which for a long period, the protrusion of the eyeball was the outstanding or the only disturbance.

LITERATURE

In 1887, Durante published the report of a case of meningeal tumor in the anterior cranial fossa, which had caused mental changes, unilateral exophthalmos, and loss of the sense of smell. The cribriform plate of the ethmoid was destroyed on the same side and the roof of the orbit was depressed. Five years later, E. Mueller published the results of a study of 168 cases of frontal lobe tumor. Three of the patients had protrusion of the eyeball on the side of the lesion, and in a fourth the protrusion was bilateral. This author expressed the belief that in tumors in the anterior cranial fossa, the exophthalmos may be the result of erosion of bone and extension of the neoplasm into the orbital cavity, of paralysis of the muscles that move the eyeball, or of circulatory disturbances.

Flatau, in 1903, contributed a very interesting paper on the connection between exophthalmos and intracranial pressure, based upon 10 cases collected from the literature and 5 that he had personally observed. The protrusion of the eyeballs was bilateral in 14 of the patients, although one eyeball was sometimes more prominent than the other. In a case of tumor of the pons, there was a unilateral exophthalmos. The cases included tumors in different parts of the cranial cavity, brain abscess, meningitis, and hydrocephalus, and in all there was an increase of intracranial pressure. Flatau believes that the chief factor in the production of the exophthalmos was increased intracranial pressure and interference with the return venous flow from the orbits. According to this author, pressure on the dural sinuses in any part of the cranial cavity may result in stagnation of blood in the cavernous sinus, venous congestion within

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the orbital cavity, and exophthalmos. A disturbance of the sympathetic control of the blood vessels as a result of the increased pressure may also play a rôle. Unverricht attempted to determine whether in this respect the autonomic nervous system was of importance, but he failed to produce exophthalmos by faradic stimulation of the cervical sympathetic.

Rosenblath studied the previously reported cases of protrusion of the eyeballs secondary to intracranial tumors, and described a case of glioma of one frontal lobe in which bilateral exophthalmos occurred, and in which at the autopsy, the orbital cavities were found to be free of tumor tissue. He believes with Flatau that stagnation of blood (and venous congestion) is a frequent cause of the proptosis.

In his textbook on tumors of the nervous system, Bruns states that growths in the middle cranial fossa may extend into the orbit through the superior orbital fissure with, sooner or later, exophthalmos and ophthalmoplegia. In 1910, Weisenburg took up the study of the subject, collected 24 cases from the literature, and reported 8 cases of his own. In 5 of his cases, the protrusion was bilateral, and in 3, unilateral. In hydrocephalus due to tumor, the exophthalmos is apt to be bilateral, and in unilateral growths, only one eyeball may be affected. In his own patients, unilateral ocular protrusion occurred in a patient with a third ventricle tumor, in one with a growth in the middle cranial fossa, and in a third, after operation, in a case of a growth in the brain stem and the cerebellar hemispheres. Weisenburg believes that interference with the venous flow through the cavernous sinus either directly by the pressure of a neoplasm or indirectly as the result of a high degree of intracranial pressure, is a frequent cause of increasing prominence of one or both eyeballs.

Cushing (3) in a paper on the cranial hyperostoses produced by meningeal growths, refers to one case of meningioma in the middle fossa in which protrusion of the eyeball of the same side had existed for 10 years, and states that in most of the meningeal growths in this situation with an associated hyperostosis, there is an exophthalmos on the same side.

In a report upon the orbito-ethmoidal osteomata having intracranial complications, Cushing (4) described 3 cases in which unilateral exophthalmos occurred. This paper was soon followed by one by Benedict, in which 3 similar cases were described. Five cases of unilateral exophthalmos were reported by Houser, 1 of which was due to intracranial tumor, 1 to cavernous sinus thrombosis, a third due to arteriovenous aneurism of the internal carotid artery and the cavernous sinus, and 2 due to disease within the orbit. Three causes of protrusion of one eyeball are mentioned: lesions within the orbital cavity, stagnation in the orbital veins, and paralysis of the orbital muscles. McLaurin in a paper on unilateral exophthalmos, states that a variety of cranial and intracranial lesions may produce the condition, and he refers especially to hydrocephalus and to oxycephaly.

In Puusepp's monograph on tumors of the brain, 3 cases of protrusion of the eyeball are mentioned. In 1 of 16 patients with frontal lobe tumors, there was unilateral exophthalmos, and in this case the growth had perforated the roof of the orbit and had invaded the orbital cavity. Among 6 cases of tumors of the temporal lobe, there was protrusion of the eyeball on the same side as the neoplasm in 1 patient.

In the monograph of Cushing and Bailey on tumors arising from the blood vessels of the brain, there are clinical records of 2 patients in whom unilateral exophthalmos was observed and of 2 others in whom there was a bilateral protrusion of the eyeballs. In the latter, the eyeball on the side of the intracranial lesion was the more prominent of the two. These 4 cases occurred among 12 cases of supratentorial venous and arteriovenous angiomata.

The latest report on the subject of exophthalmos complicating intracranial lesions was found in a paper by Rowland on the so called Christian syndrome. In 15 cases of this disease in which exophthalmos was observed, the protrusion of the eyeballs was bilateral in 10 and unilateral in 5 patients. In all, the protrusion of one or both eyeballs was due to extension of the disease from the cranial into the orbital cavity.

This survey of the literature shows that all of the authors agree that an increase of intracranial pressure may produce exophthalmos, which may be unilateral or bilateral. We suspect that in many of the patients in whom a prominence of only one eyeball was believed to be the result of a general increase of intracranial pressure, careful exophthalmometric measurements might have shown that there was also some protrusion of the other globe. In our series of brain tumors, slight bilateral exophthalmos was not very rare, especially if for a long period there had been a dilatation of the third as well as of the lateral ventricles. Slight protrusion of one or of both eyeballs would probably be a frequent finding if measurements were made as a routine.

The writers who discuss the subject of etiology believe that when the intracranial disease has not directly invaded the orbital cavity, venous stasis is an important factor in the production of exophthalmos, and that, in intracranial tumors, the neoplasm may make direct pressure upon the cavernous sinus or upon the ophthalmic vein with a resulting venous stasis and increased prominence of one or both eyeballs. Most writers also state that in intracranial expanding lesions, some degree of proptosis may be due to paralysis of the ocular muscles as the result of interference with their nerve supply. As is well known, the eyeball is to some extent held in position by the four rectus muscles, while the two oblique muscles, if unopposed, rotate the eyeball and pull it forward. Therefore, if some of the ocular muscles were affected, the action of other muscles might cause a certain amount of protrusion of the globe. It must be rare, however, when there is pressure upon them or their nerve supply in the middle cranial fossa, that some muscles are paralyzed and others not.

To what extent, if at all, a disturbance of the sympathetic nerve supply to the eyeball may have etiological significance is, as yet, undecided. It is well known that a lesion of the cervical sympathetic or removal of the cervical sympathetic or of the stellate ganglion will produce enophthalmos, but it does not follow that irritation of these structures will produce the opposite condition, i.e., increased prominence of the eyeball.

Fig. 1. Case 1. Appearance of the patient before operation and after operation.

From our own experiences, it is probable that distinctly unilateral exophthalmos in tumors within the cranial cavity, is most often produced by direct encroachment of a neoplasm or bone disease upon the contents of the orbital cavity or pressure transmitted to the orbit through the superior orbital fissure. It may be that direct pressure upon the large vessels through which the venous blood from the orbit and the eyeball is carried, is a contributing factor.

THE FREQUENCY OF UNILATERAL EXOPHTHALMOS IN A SERIES OF INTRACRANIAL TUMORS

In our series of 807 cases of verified intracranial neoplasm (up to December 1, 1931), marked protrusion of one eyeball occurred in 15 patients, or in 1.9 per cent.

In 139 patients of this series, the new-growth was situated on one or on both sides of the anterior cranial fossa or in the anterior part of the middle fossa, and among these, unilateral exophthalmos occurred in 15, or in 10.8 per cent. Sixty-one of the 139 patients had meningiomata and in 10 of these there was a protrusion of one eyeball (16 per cent). As there were 10 meningeal tumors among the 15 cases of growths with unilateral exophthalmos, the incidence, in this respect, was 66 per cent.

The meningiomata (and the cranial hyperostoses which occur in these growths) are a frequent cause of protrusion of *one* eyeball. Slight prominence of *both* eyeballs was noted

Fig. 2. Case 2. Condition before and after first operation.

in the clinical records of a number of our patients with intracranial growths, but the exophthalmos was never so marked that it was easily noticeable, and never caused the marked deformity that was observed in the 15 patients of this series. We have not observed marked exophthalmos in any case of frontal or temporal lobe glioma, of pituitary or bucconeural pouch tumor. In Cushing's monograph on pituitary tumors, there is no illustration or description of a case with unilateral exophthalmos.

TABLE I.—RELATIVE FREQUENCY OF UNILATERAL EXOPHTHALMOS

Total number of tumors	807
Total number of tumors in frontal and temporal lobes.	139
Total number of tumors with unilateral exophthalmos	15
Among 807 tumors, unilateral exophthalmos occurred in 1.9 per cent.	
Among 139 tumors in the frontal or temporal lobes, unilateral exophthalmos occurred in 10.8 per cent.	
Among 61 meningiomata in the frontal or temporal lobes, unilateral exophthalmos occurred in 16 per cent.	
Among 15 tumors with unilateral exophthalmos, there were 10 meningiomata, or 66 per cent.	
The pathological nature of the 15 tumors was the following:	
Meningioma	10
Orbito-ethmoidal osteoma	2
Adenocarcinoma of scalp and skull, primary	1
Epidermoid	1
Paget's disease with large hyperostosis and intracranial tumor	1
	15

The frequency with which meningeal growths with large cranial hyperostoses in the anterior part of the skull, cause a protrusion of one eyeball is so great that one is apt to think only of a meningioma when a case of this kind is examined. As our 15 cases demonstrate, unilateral exophthalmos and a bony prominence on the skull occur in many different types of growth, and we have seen both conditions associated in primary carcinoma of the scalp and bone, in Paget's disease invading the cranial cavity, in an intracranial epidermoid

Fig. 3A. Roentgenogram showing the destructive changes in the frontal region of the skull in Case 2.

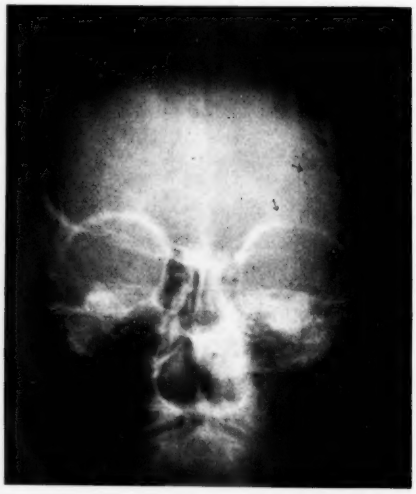

Fig. 3B. Roentgenogram showing the destructive changes in the frontal region of the skull in Case 2.

and in orbito-ethmoidal osteomata. There is no reason why protrusion of an eyeball may not occur in other types of intracranial new-growth. It is certainly not so very rare in metastatic disease of the bones of the skull with intracranial complications and in arterial and arteriovenous angiomata. In the malformations of the cerebral blood vessels, however, the exophthalmos is usually bilateral, although one eyeball may be more prominent than the other.

THE SITUATION OF THE LESION WHICH PRODUCES THE EXOPHTHALMOS

The protrusion of the eyeball was on the left side in 9, and on the right side in 6 of the 15 patients. Eight were females, and 7 were males. The lesion was on the left side in 7 of the 8 females, and on the right side in 5 of the 7 males. This *predilection for the left side in females, and for the right side in males* is of interest. In the literature, the cases in men of unilateral exophthalmos due to an intracranial lesion most often occurred on the right side.

As has been mentioned in an earlier part of this report, in all of our patients the growths lay in the anterior or the middle cranial fossa, or in both. In most of the instances in the literature and in all of our cases in which the tumor was limited to the anterior cranial fossa, there were either marked bony changes or the growth had perforated into and occupied space in the orbital cavity. This fact is, of course, easy to understand. A tumor which does not extend beyond the limits of the anterior cranial fossa and which has not eroded or produced some other change in the roof or walls of the orbit, or which has not caused a localized increase of pressure in the homolateral middle fossa, can not cause a dislocation of the orbital contents. The veins which drain the orbit, the muscles which move the eyeballs, and the nerves which innervate the ocular muscles lie in the middle cranial fossa, and they would not be involved by a neoplasm in the anterior cranial fossa unless it had encroached upon or had caused a localized increase of pressure in the middle cranial fossa.

Theoretically, tumors in and around the temporal lobe in the middle cranial fossa may make pressure upon the cavernous sinus, the ophthalmic vein, or upon the nerves which pass to the muscles which move the eyeball. More often, however, the growths invade the orbital cavity through the superior orbital fissure. It is not necessary that the neoplasm itself shall have extended forward into the orbit either by eroding bone or through the superior orbital fissure—the hyperostosis on the floor of the skull associated with a meningioma may produce the exophthalmos as the result of thickening or enlargement of some part of the orbital walls. Whether an increase of pressure in the middle cranial fossa can produce sufficient venous stasis within the orbit so that the eyeball will markedly protrude, is doubtful. As we shall mention in another part of this report, such a mechanism could not be demonstrated in any of our patients. We are inclined to the view that the

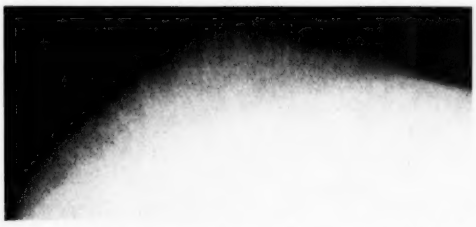

Fig. 4. Roentgenogram showing hyperostosis and spicule formation in Case 2.

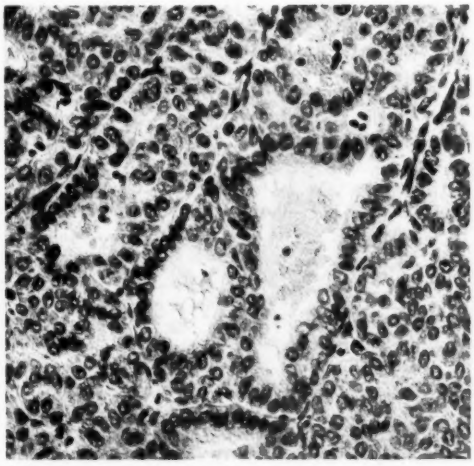

Fig. 5. Showing the characteristic structure of an adenocarcinoma in the tumor removed in Case 2.

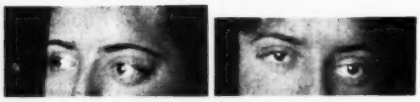

Fig. 6. Case 3. Protrusion in the left frontal region and the left exophthalmos in a patient with an orbito-ethmoidal osteoma.

rise of pressure is transmitted to the orbital contents through the superior orbital fissure and that the exophthalmos results from the effect of this increase of pressure upon the contents of the orbit.

Therefore, if there are the signs of a neoplasm in the anterior cranial fossa with unilateral protrusion of the eyeball, but if the X-ray does not show absorption of the roof of the orbit or other changes in the bone, it is probable either that the neoplasm has extended backward into the middle cranial fossa or that the growth lies mainly, if not entirely, behind the posterior border of the lesser wing of the sphenoid bone.

Of our 15 cases, the tumor lay entirely in the anterior cranial fossa in 3 patients, and in all, the roentgenogram showed that there had been some destruction of the orbital plate and extension of the growth into the orbital cavity. Two of the patients had orbito-ethmoidal osteomata, and in the third, a meningeal tumor had both eroded and had caused a marked thickening of the bony roof of the orbit.

In the 12 remaining patients, the neoplasm lay mainly or entirely in the middle fossa.

CLINICAL AND DIAGNOSTIC NOTES

The protrusion of the eyeball had often been noticed for a long period before the patient came under our observation, and a history of exophthalmos dating back many years (4 to 10 or more) was not unusual. In the patients in whom the exophthalmos had existed for a relatively short time—one year or less—other disturbances brought the patient to the hospital. Some of the patients were referred to us because of the increasing size of the cranial hyperostosis, others came because of diminished vision, still others on account of headache and other symptoms of an increase of intracranial pressure.

Clinically, the cases could be divided into the following groups:

A. Patients whose only complaints were those referable to the changed position of the eyeball and to the deformity caused by a cranial hyperostosis or a bony swelling in the frontal region. Excepting for the proptosis and the bony changes, the examination failed to show any neurological disturbances. The following short clinical histories are typical of this group:

CASE 1. A history of unilateral exophthalmos and a cranial hyperostosis of 4 years' duration. No other

Fig. 7. Case 3. Roentgenogram showing characteristic appearance of orbito-ethmoidal osteoma.

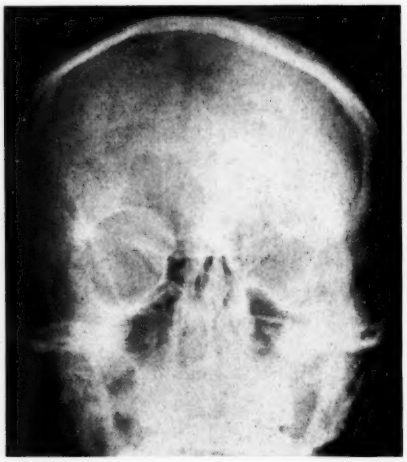

Fig. 8. Case 3. Roentgenogram showing the protrusion of the osteoma into the orbital cavity.

symptoms. Removal of a meningioma and of the hyperostosis. Recovery.

M. S. H. 296024. Fannie G., 19 years of age, first admitted to hospital on March 13, 1925, gave a history of a swelling in the left frontotemporal region with gradual increasing bulging of the left eyeball of 4 years' duration. The patient did not suffer from headache or other symptoms.

Physical examination was entirely negative, except for the local changes in the skull and eyeball. The left frontal and temporal regions were occupied by a large bony swelling and the left eyeball protruded downward and outward. The exophthalmometric readings were: right eye, 16; left eye, 21; at 105 degrees. The pupils were equal and reacted promptly to light and accommodation. Vision was good in both eyes and the visual fields were complete. The fundi were normal. There was slight limitation of all movements of the left eyeball.

The X-rays of the skull showed that there was a thickening of the anterior part of the left parietal and of the contiguous part of the left frontal bone.

During the course of several years, the patient was given X-ray treatment and three operations were performed. Following the removal of the hyperostosis and of the intracranial meningioma, there was marked diminution in the protrusion of the eyeball (Fig. 1).

This was a typical case of a meningioma with a large hyperostosis which had produced no disturbances except the deformity of the skull and the protrusion of the eyeball. The exophthalmos was the result of pressure upon the orbital contents of the thickened bone and there was no evidence that the neoplasm had perforated into or had invaded the orbital cavity.

Fig. 9. Case 4. Unilateral exophthalmos in a patient with a large meningioma in the left frontal and tempora regions.

In the following case, the exophthalmos was secondary to extensive bone disease in the anterior and middle cranial fossæ on the left side:

CASE 2. A history of unilateral exophthalmos and frontal swelling of 1 year's duration. At operation, an adenocarcinoma was partially removed.

N. I. 7577. Jennie W., 50 years of age, was admitted with the history that, about 1 year before, a protrusion of the left eye had been noticed and had gradually become more marked, and that a swelling in the left frontal region had appeared and had slowly increased in size. The patient did not suffer from headache and had no other complaints.

The examination failed to show any evidence of disturbances neurological in character. The patient was very co-operative, speech was normal, and mentally she was bright and alert. There was a marked exophthalmos on the left and a bony swelling in the left frontal region. The movements of the left eyeball were limited in all directions; the vision of the left eye was 20/20 and the fields of

Fig. 10A. Case 4. Roentgenogram showing the hyperostosis.

Fig. 10B. Case 4. Roentgenogram showing the hyperostosis.

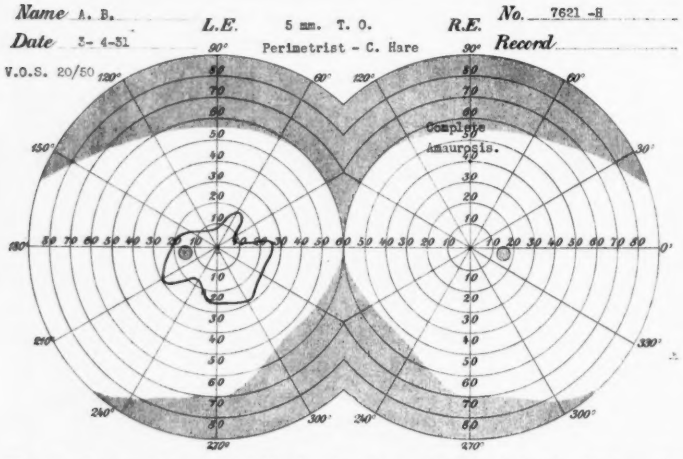

Fig. 11. Case 5. The visual fields showing the small amount of vision that remained.

both eyes were complete, the pupils of the two eyes were equal in size and both reacted well to light and accommodation. The fundi were normal.

The X-ray examination showed that there was a profound bony change in the left frontal region which involved almost the entire left frontal bone. The roentgenological appearance was that of extensive bony destruction with the spicule formation so characteristic of the hyperostoses seen in the meningiomata (Figs. 3 and 4).

At the operation, the hyperostosis which had invaded the cranial cavity was removed but no neoplasm was found inside of the dura. The pathological examination revealed that the bony change was due to an adenocarcinoma which was probably derived from a sweat gland (Fig. 5). The patient recovered satisfactorily from the operative procedure, but the exophthalmos did not improve. She received intensive X-ray therapy. Further roentgen studies demonstrated an advance in the bone destruction which gradually involved the floor of the skull on the left side. Six months after the operation, the protrusion of the eye was more marked, but the patient was still free from other symptoms (Fig. 2).

Before the operative interference, the diagnosis was "frontal meningioma with hyperostosis causing unilateral exophthalmos." This case demonstrated that a typical hyperostosis does not always mean that one is dealing with a meningeal growth. The extensive bone absorption might have led to the suspicion of malignant disease. Hyperostoses may occur with malignant bone tumors in other parts of the body, and such cases have been reported.

The following is a characteristic story of a bony growth which had perforated into the orbit and the frontal sinus and had produced a protrusion of one eyeball.

CASE 3. Orbito-ethmoidal osteoma causing exophthalmos and a swelling in the frontal region.

N. I. 10096. Ruth R., 17 years of age, was admitted into the hospital on account of a bulging in the left frontal region of 2 years' duration. The swelling had become progressively more prominent. One year ago, the protrusion of the left eye began to be noticeable, and this has likewise become more marked.

The physical examination was entirely negative except for the local condition. Speech was normal. The fields were complete and vision and the fundi were normal. There was perhaps a slight limitation of the eyeball upon gaze to the left. The left eyeball was abnormally prominent and protruded downward and outward. There was a noticeable swelling in the left frontal region (Fig. 6). The X-ray report stated: "In the left frontal region there is a large irregular mass of calcification which measures 3.7 by 3.3 by 2.5 centimeters. This shadow is irregular in density. The central portion is less dense than the peripheral portion. The superior orbital plate on the left side appears denser than normal. A small portion of this mass projects into the orbital cavity and the left frontal sinus is also apparently involved" (Figs. 7 and 8).

At the operation, an orbito-ethmoidal osteoma was entirely removed.

B. In a second group, the patients had an increasing exophthalmos and perhaps a visible hyperostosis for a long period, and then began

Fig. 12A. Case 5. Lateral roentgenogram showing the hyperostosis on the floor of the skull.

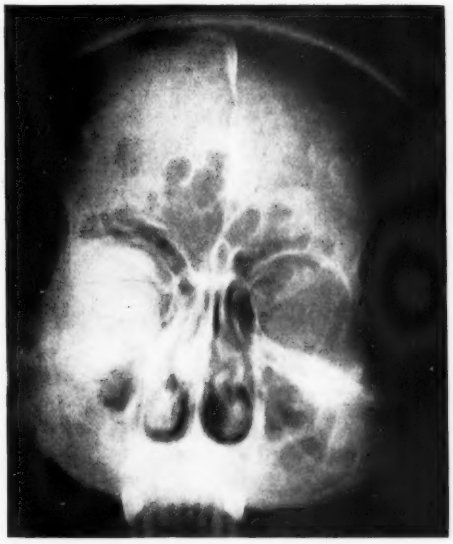

Fig. 12B. Case 5. Roentgenogram showing the hyperostosis behind the right orbit.

to suffer from symptoms which led to their admission into the hospital. In many of these individuals, there were, upon examination, no neurological or other disturbances except the local condition of the eyeball. One of our patients was referred about 10 years from the time that the protrusion of the one eye had been noticed, because she had suddenly had a convulsive seizure. Another came because of failing vision 4 years after the first evidence of the unilateral exophthalmos. In a third case, attacks of headache began 9 months after the prominence of the eyeball had first been noticed.

CASE 4. A history of unilateral exophthalmos without other symptoms for 9½ years. A generalized convulsive seizure was the cause of the patient's admission into the hospital. Partial removal of a large meningioma. Death.

N. I. 8786. Mrs. C., 36 years of age, had had a slowly increasing prominence of the left eyeball without other symptoms, for almost 10 years. On the day before admission, she had, suddenly, a generalized convulsive seizure with unconsciousness, on account of which she was sent into the hospital by her physician.

The patient was bright, co-operative, and perhaps a little euphoric. Physical examination was entirely negative, except for loss of sense of smell and the local changes.

The left eyeball protruded markedly downward and to the left (Fig. 9), the globe felt tense, the discs were somewhat pale, the pupils were equal and reacted promptly to light and accommodation. In spite of the marked proptosis, the movements of the left eyeball were only slightly limited. X-ray examination: On the left side the lesser wing of the sphenoid, the posterior wall of the orbit, and the superior orbital plate were markedly thickened (Fig. 10). The change involved also the left anterior clinoid process and the greater wing of the sphenoid on the same side. There was a large amount of flocculent calcification in the left temporofrontal region.

The diagnosis of a meningioma underneath the left temporal and frontal lobes was made, and operative interference decided upon. At the craniotomy, the bone was found so thick and vascular, that the attempt to make a bone flap and to expose the neoplasm had to be done in three stages. At the third operation, considerable of the tumor was removed, but it was so extensive that its complete extirpation was impossible. One week after the last operation, the patient suddenly had a discharge of 30 cubic centimeters of pus from the nose and mouth and then began to have fever. As the operative wound was well healed, this led to the belief that the tumor had perforated into one of the air sinuses. The patient succumbed 10 days after the operation.

A large meningeal tumor, which had probably existed for 10 or more years, had pro-

Fig. 13A. Roentgenogram showing the irregular defect in the orbital plate on the left side in Case 6, an epidermoid in the middle cranial fossa.

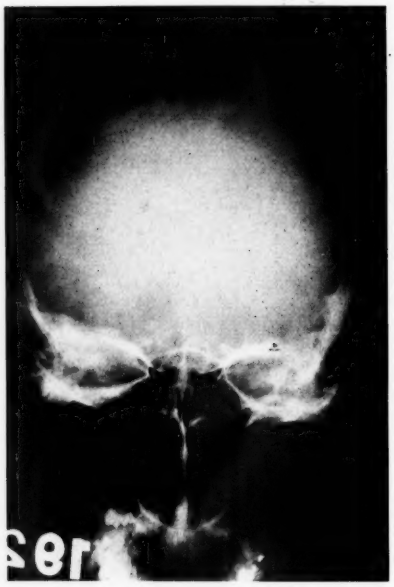

Fig. 13B. Roentgenogram showing the irregular defect in the orbital plate on the left side in Case 6, an epidermoid in the middle cranial fossa.

duced extensive bony changes in the skull and had caused a slowly increasing exophthalmos. The protrusion of the eyeball without any other subjective disturbances had not been considered of serious import. A convulsive seizure was the cause of the patient's admission to the hospital. If the significance of the exophthalmos had been appreciated and the patient had been operated upon many years before, the result might have been a different one. The same paucity of symptoms was the explanation for the story of the next patient:

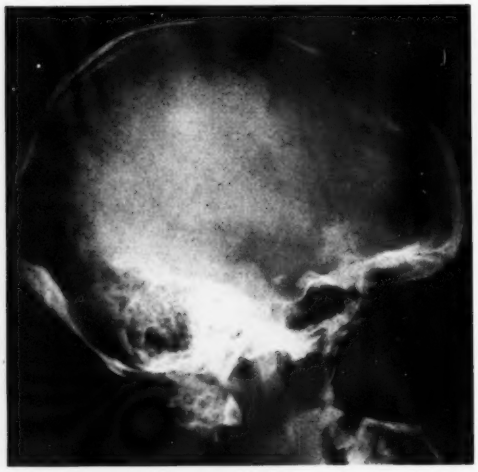

Fig. 13C. Roentgenogram showing the irregular defect in the orbital plate on the left side in Case 6, an epidermoid in the middle cranial fossa.

CASE 5. Unilateral exophthalmos with loss of sight in the affected eye. Diminution of vision in the other eye was the cause of the patient's admission.

N.I. 7621. Anna B., 55 years of age, was admitted for study on March 4, 1931. Twenty-one years before, a bulging of the right eye had been first observed and vision in that eye had been gradually lost. The exophthalmos persisted and slowly became more marked. Three years ago, the vision in the left eye began to fail and sight in that eye had slowly become less up to the time of admission. The patient had not suffered from headache, and there had been no complaint except the visual disturbance.

Physical examination: Smell was lost on the right. There was marked protrusion of the right eyeball, and the movements of that globe were limited in all directions. The right pupil did not react to light, and the left reacted sluggishly. Vision was lost on

Fig. 14. Slight exophthalmos and large hyperostosis in a patient with a large meningioma in the left frontal region, before operation.

Fig. 15. Slight exophthalmos and large hyperostosis in a patient with a large meningioma in the left frontal region, after operation.

the right, and there was only central vision on the left (Fig. 11). Both optic discs were pale from primary optic atrophy. X-rays of the skull showed a thickening and increase in density of the greater and lesser wings of the sphenoid on the right side with a definite hyperostosis of the floor of the middle cranial fossa on the right. The change was characteristic of that seen in meningeal growths in the middle cranial fossa (Fig. 12).

Operation was recommended in order to save vision, but on account of the absence of any other symptoms of brain tumor except the unilateral exophthalmos and failing vision, the patient and her family refused to give permission for surgical interference.

In a third patient, the exophthalmos had existed for 9 months, but headache and pain in the eyeball had led the patient to seek relief.

CASE 6. Unilateral exophthalmos for 9 months followed by headache and pain in the affected eye. At the operation a large epidermoid was disclosed and removed.

N.I. 7025. Marjory F., 35 years of age, had noticed that the left eyeball had become progressively more prominent for 9 months. Two months

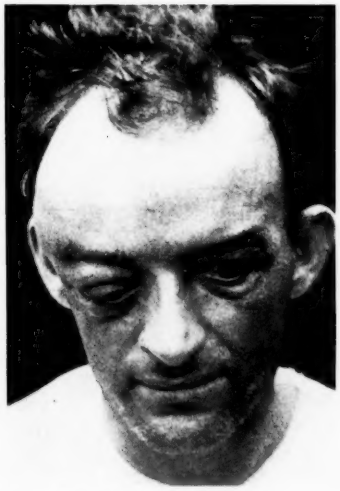

Fig. 16. Unilateral exophthalmos and hyperostosis in a patient with a right frontal meningioma.

Fig. 17. Roentgenogram of patient shown in Figure 16, showing the bony changes in the frontal region.

Fig. 18. Unilateral exophthalmos and hyperostosis in a patient with a left temporal lobe meningioma, before operation and after operation.

before admission, she began to suffer from attacks of headache with pain in the left eyeball.

The patient was a robust young woman who had no complaints except those above mentioned, and the examination failed to show any neurological disturbances. The left eyeball was pushed downward and outward with the exophthalmometer, right eye 15; left eye 19 at 95 degrees. There was some limitation of the movements of the left eyeball to the left. Vision was 20/50 in the right eye and 20/100 in the left. The pupils were equal and reacted promptly to light and accommodation. There was a slight blurring of the margins of both optic discs.

Fig. 19. Anteroposterior roentgenogram showing irregular defect in the orbital wall of the patient shown in Figure 18. Note the separation of the coronal sutures.

Fig. 20. Unilateral exophthalmos in a patient with advanced arterial disease and unverified tumor under the left frontal lobe.

X-ray examination showed a definite thickening of the superior orbital plate and a hyperostosis of the frontal bone on the left which extended laterally to involve the greater wing of the sphenoid on the same side. There was a definite defect 3 by 1.5 centimeters in size in the orbital plate, and the margins of the defect were smooth (Fig. 13).

As a diagnosis of middle fossa meningioma seemed justified, a bone flap was turned down. A large epidermoid containing much cholesterin and caseous material was found and removed. The protrusion of the eyeball soon disappeared, and the patient has remained well.

In spite of the hyperostosis, the clean cut and smooth walled defect in the superior orbital plate was not typical of the destructive changes in the bone observed in meningeal growths, and in a similar case, an X-ray diagnosis of middle fossa meningioma should be made with many reservations. The changes seen on the X-ray films were difficult to interpret, and one very experienced observer even suspected a congenital anomaly. The case again demonstrated that other conditions in addition to meningeal growths may produce unilateral exophthalmos and a hyperostosis.

C. In a third group of patients, there was a history, dating back a number of years, of slowly progressive enlargement of the bone in one frontal region with, finally, the occurrence of unilateral exophthalmos, followed by symptoms and signs of increased intracranial pressure. All of the patients had meningeal growths with cranial hyperostoses, and the changed bone as well as the intradural tumor made pressure upon the structures in the middle cranial fossa. One of the patients had been seen for several years before the onset of signs of increased pressure and of loss of function and she only gave consent for the surgical interference after a hemiparesis had developed (Figs. 14, 15, 27, 28). A somewhat similar story was obtained from another individual

whose photograph and X-rays are reproduced in Figures 16 and 17. In still another patient, unilateral exophthalmos developed during the course of 8 months and was caused by a large meningeal fibroblastoma which lay underneath the left temporal and frontal lobes. In this patient, the protrusion of the eyeball (Fig. 18) was the result of the pressure of the neoplasm through a greatly enlarged superior orbital fissure (Fig. 19). In one patient, who is suffering from advanced arterial disease, surgical interference has not been advised, and the diagnosis of meningioma has not been verified (Fig. 20).

Fig. 21. Unilateral exophthalmos in a patient with an orbito-ethmoidal osteoma.

THE CHANGES IN THE POSITION AND THE LIMITATION OF THE MOVEMENTS OF THE AFFECTED EYEBALL. DISTURBANCES OF VISION AND OF THE VISUAL FIELDS

In the short histories of some of the patients that have been given in this paper, little has thus far been said regarding the local conditions in the orbit and the changes in the eyeball itself. As the photographs of the patients demonstrate, the eyeball was most often pushed forward, downward, and outward. This was due, no doubt, to the fact that perforation of the orbital roof occurred more often in the medial part of the roof, and hyperostotic changes in the base were most marked in the more mesially placed lesser and greater wings of the sphenoid bone and the adjacent orbital walls. In the 2 cases of orbito-ethmoidal osteoma (Figs. 7, 8, 21, 22), the bony growth lay close to the midline of the skull in both instances and the perforation of the orbit was correspondingly near the mesial part of the roof of the orbit. In the 3 patients (Figs. 16, 23, 24) in whom the eyeball had been pushed

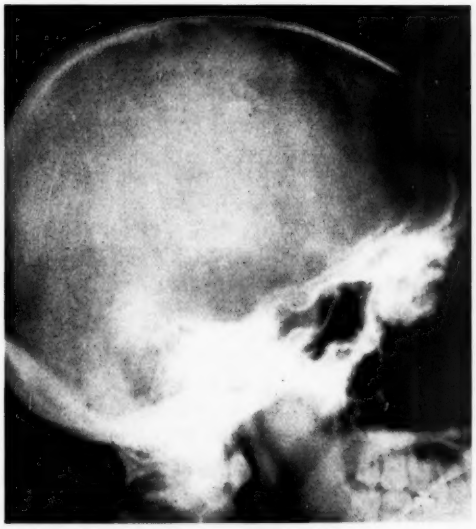

Fig. 22A. Roentgenogram showing the orbito-ethmoidal osteoma in the patient shown in Figure 21.

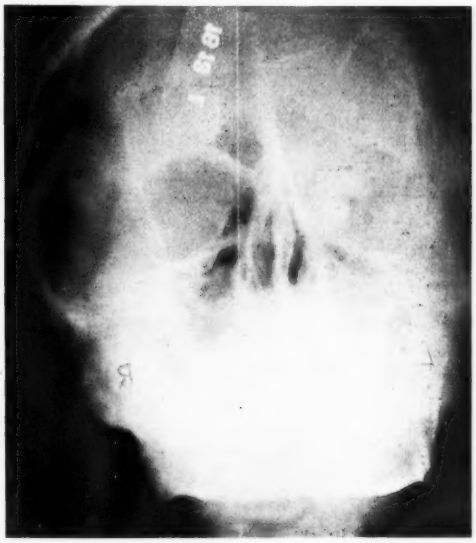

Fig. 22B. Roentgenogram showing the orbito-ethmoidal osteoma in the patient shown in Figure 21.

Fig. 23. Unilateral exophthalmos and hyperostosis in a patient with a right frontal meningioma. The eyeball is pushed downward and inward.

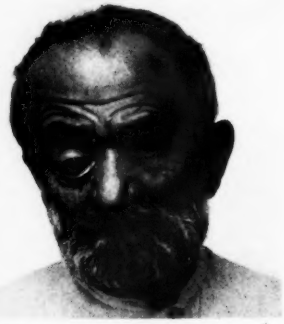

Fig. 24. Paget's disease with intracranial tumor, hyperostosis, and unilateral exophthalmos. The eyeball is pushed downward and inward.

downward and inward, there was a large hyperostosis in the more lateral part of the frontal bone, and the lateral wall of the orbit was especially involved.

The direction in which the eyeball is dislocated will vary with the cause and the location of the increase of intra-orbital pressure. If the pressure is from the inner part of the orbital wall or directly through the superior orbital fissure, the eyeball will be pushed outward as well as forward; if the pressure is from the side, the globe will be pushed inward as well as forward; and if it is also from above or below, the protrusion will be also in a downward or an upward direction. In the cases of bilateral protrusion observed in increased intracranial pressure due to chronic hydrocephalus and brain tumors, the proptosis usually is directly downward and forward, without any marked deviation to the one or other side.

In most of the patients, the movements of the affected eyeball were limited in all directions, but the limitation was not always directly proportionate to the degree of protrusion of the eyeball. In some of the patients in whom the exophthalmos was very marked, there was little interference with the free movement of the affected globe, or the limitation was only in upward and downward gaze.

As was to be expected, the affected eyeball was always more tense than that of the other side, and when the attempt was made to push the globe back into the orbit, a much greater sense of resistance was felt than when a similar procedure was tried on the other eyeball. Palpation of, or pressure upon, the eyeball caused pain in the patient who had an epidermoid in the middle cranial fossa which had perforated into the orbital cavity.

Unless vision was markedly compromised, the pupils of the two eyes were equal in size, and the pupil of the affected eye contracted as well to light and to accommodation as that of the other side.

The vision of the affected eye was well preserved in 6 of the patients; there was some diminution of vision in 5; marked diminution in 3; and all vision had been lost in the eye in 1 patient (Case 5). Unless a previous or co-existing papillœdema had produced more or less diminution of visual acuity, the vision of the other eye was normal in all but 1 of the patients. There was nothing characteristic in the visual fields of the affected eye. In most instances, the fields were normal in shape and size; in a few there were large scotomata; in 3 patients a temporal defect was found on the affected side (Fig. 25). In the patients with papillœdema, there was, of course, more or less contraction of the fields of vision of both eyes.

The fundus changes varied within wide limits. In some of the patients, the affected eye showed a primary optic atrophy. On the side of the lesion, the margins of the disc were sometimes definitely blurred and indistinct, while the fundus of the opposite eye showed nothing abnormal. If there was a papillœdema, it was found in both eyes, as an evidence of intracranial pressure. Unless there was a definite papillœdema, distinct conges-

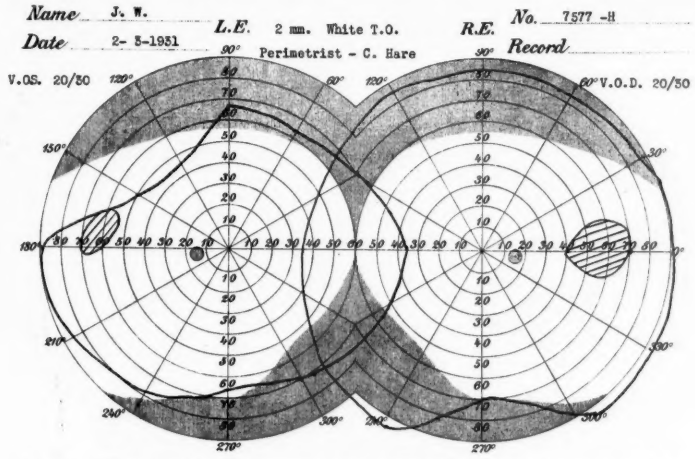

Fig. 25. Visual fields of a patient with a unilateral exophthalmos on the left, showing temporal defect in the left visual field.

tion of the veins of the retina of the affected eye was rarely observed. The absence of stasis in the retinal veins was surprising and led us to conclude that in our series of patients, the exophthalmos was not due to venous stasis in the orbit and the result of compression of the cavernous sinus or the ophthalmic vein.

As the protrusion of the eyeball prevented complete closure of the lids, a lagophthalmos was observed in all of the patients. Chemosis of the lower or of both lids and more or less congestion of the conjunctivæ were frequently observed.

THE ROENTGENOLOGICAL CHANGES

The roentgenograms of 10 of the patients were used as a basis for the following remarks. The films of the 5 other patients were, for one or another reason, not available. The cases included 2 of orbito-ethmoidal osteoma, 1 of adenocarcinoma of the scalp and bone, 1 of epidermoid, and 6 of meningioma.

In 7 of the cases—the 6 meningiomata and the single adenocarcinoma—there were X-ray signs of a general increase of intracranial pressure, and in 2 of them the sella turcica was markedly deformed. Atrophy of the posterior clinoid processes, the dorsum sellæ, and the floor of the sella turcica were the only evidence of increased intracranial pressure in 6 of the patients. The roentgenograms of one patient (Fig. 19), who had a meningioma involving the anterior portion of the left middle cranial fossa, also showed separation of the coronal and lambdoid sutures.

In the two osteomata and in the epidermoid, there was no roentgenological evidence of pressure—which can be explained by the

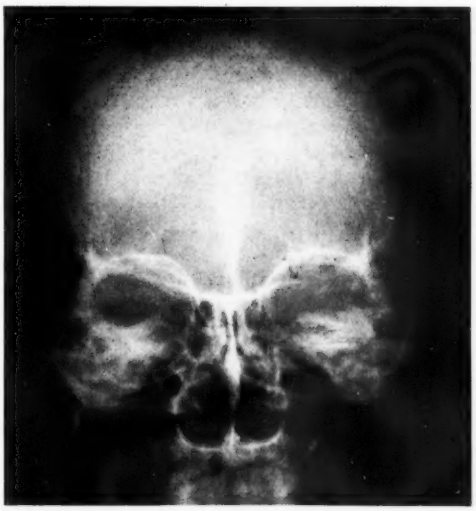

Fig. 26. Roentgenogram showing destructive changes in the left sphenoid ridge in a patient with a meningioma and exophthalmos.

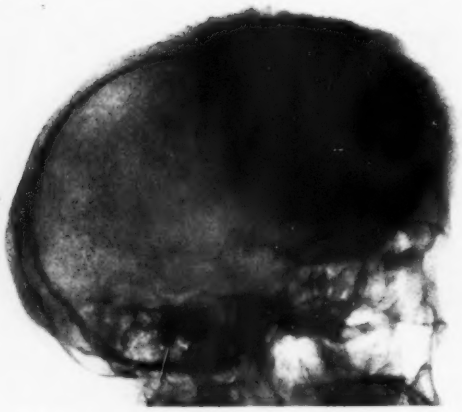

Fig. 27. Roentgenogram showing hyperostosis in a patient with unilateral exophthalmos.

Fig. 28. Anteroposterior roentgenogram of same patient as shown in Figure 27.

slow growth of the tumors and their position. The slow increase in size of these two types of tumors appears to be the most important factor, for we have not infrequently seen other tumors in practically the same situation which produced definite roentgenological signs of increased intracranial pressure.

Calcification was seen in only one of the patients of this series—a far advanced meningioma in the left middle cranial fossa (Fig. 10). The X-rays in the case of the adenocarcinoma showed the marked spicule formation (Fig. 4) which is usually indicative of a meningeal growth.

In all of the 10 cases of this series, the walls of the orbit were involved, and there was either a definite hyperostosis or thickening or destruction or absorption of the bone. The orbital cavity was therefore directly invaded in all of the patients.

The superior orbital fissure was definitely involved in 5 cases; in 3 it was enlarged as the result of bone absorption or destruction, while in the other 2 there was a definite thickening of part of its walls. In all of these 5 cases, the neoplasm was a meningioma.

When a patient with unilateral exophthalmos is examined by the roentgenologist, a careful stereoscopic study of the orbital plate of the frontal bone and of the greater and lesser wings of the sphenoid should always be made. In 6 of our patients the orbital plate of the frontal bone, and in 7, the sphenoid bone were involved.

The predominant change in the bone was productive. In 8 of the cases, there was a definite hyperostosis, and in 5 of these there was also on the X-ray films evidence of bone destruction. In two of the patients with meningiomata (Figs. 19 and 26), the bony changes were entirely destructive—in one instance involving the left sphenoid ridge (Fig. 26) and in the other, the greater wing of the sphenoid bone (Fig. 19). In Table II, we have expressed the degree of bony change by plus signs. Four plus signifies the maximum change (Figs. 10, 27, and 28) whether productive or destructive, and one plus, the minimum change (Fig. 13 A, B, C).

The study of the films demonstrated that the superior and posterior portions of the orbital cavity were most frequently encroached upon. This was to be expected on account of the frequency with which the pathological process was located in the greater wing of the sphenoid and the orbital plate of the frontal bone.

Osteomata arising within the cranial cavity are infrequent and form less than one-half of one per cent of all intracranial growths. As seen on the X-ray films, they are of two types —cauliflower-like growths with various degrees of density in different parts of the neoplasm and sclerosing tumors. Both increase

TABLE II.—ROENTGEN RAY FINDINGS IN TEN PATIENTS WITH UNILATERAL EXOPHTHALMOS DUE TO INTRACRANIAL TUMORS

Name	Diagnosis	Evidences of pressure	Calcification or bony tumor	Superior orbital fissure	BONES INVOLVED				Predominating bone lesion		Portion of bony orbit involved
					Ethmoid	Frontal	Sphenoid	Temporal	Productive	Destructive	
R. R. Case 3	Osteoma (Figs. 7, 8)	None	Mass 3.6 x 4.2 x 4.0 cm.; 2/3 intracranial	o	o	Left orbital plate, bony mass	o	o	+++		Superior and extending laterally
W. B.	Osteoma (Fig. 22)	None	Mass 3.2 x 3 x 3 cm. All intraorbital	o	Arises from the junction of cribriform plate and orbital plate	Right orbital plate, smooth-edged defect	o	o	+++		Upper and inner quadrants
M. F. Case 6	Epidermoid (Fig. 13)	None	None	o	o	Left orbital plate	Orbital portion of greater wing of sphenoid	o	+	Mixed +	Posterior and upper quadrants
J. W. Case 2	Adenocarcinoma (Figs. 3, 4)	Atrophy of post. clinoids and dorsum	None	o	o	Left horizontal and upright portion	Lesser wing; orbital portion of greater wing	o	+	+++	Superior and posterolateral quadrants
H. A.	Meningioma (Fig. 19)	Separation of sutures; sella atrophic	None	Enlarged laterally	o	o	Left orbital surface of greater wing of sphenoid ridge	Anterior portion of the squamous portion		+	Superior and posterior and half
A. R.	Meningioma (Fig. 26)	Sella atrophic; floor deepened; post. clinoids thin	None	Slightly enlarged	o	o	Left sphenoid ridge	o		+	Posterior and upper quadrants
A. B. Case 5	Meningioma (Fig. 12)	Sella very atrophic	None	Slightly decreased in size	o	o	Right greater and lesser wings of sphenoid; anterior clinoid markedly thickened	Lower anterior portion of squamous portion thickened	+++		Posterior portion
E. L.	Meningioma (Fig. 17)	Atrophy of post. clinoids and dorsum	None	Increased in size	o	Right orbital plate and vertical portion, post. and lat. sup. orbital ridge and zygomatic process	Orbital surface of greater wing	Anterior part of squamous portion	++	Mixed ++	Posterior and lateral
S. C. Case 4	Meningioma (Fig. 10)	Atrophic post. clinoids and dorsum. Sella deepened	Moderate amount	Decreased in size	Left edge of cribriform plate	Left orbital plate, also at junction of frontoparietal bones	Entire greater and lesser wings, also left anterior clinoid	Anterior and inferior part of squamous portion	++++		Superior quadrant
G. B.	Meningioma (Figs. 27, 28)	Atrophy of post. clinoids and dorsum and deepened sella	None	o	o	Anterior portion of parietal bone. Orbital plate slightly involved	o	o	++++		Lateral

in size very slowly, and are usually found in one of two situations, either at the inner end of the petrous ridge, or at the junction of the cribriform plate of the ethmoid with the orbital plate of the frontal bone. The osteomata in the orbito-ethmoidal region concern us

here, and they must be distinguished from the hyperostoses produced by meningeal growths in this general situation. The differentiation by X-ray alone may be difficult.

Epidermoids are relatively infrequent—about 90 cases have been reported in the literature. The temporal region is one of their favorite sites and they may be multiple. The defect in the bone seen on the X-ray film of our one case (Fig. 13) was sharply outlined and the margins of the defect were thickened and smooth. In the meningiomata which involve the base of the skull, on the other hand, bony defects are unusual, but when they do occur, the margins are ragged and poorly defined. An increase in the number and size of the vascular channels in the bone is often seen in the meningeal growths.

In order to save space, a detailed description of the X-ray changes in all of the patients of this series is not given. A study of the accompanying table and of the roentgenograms will give the necessary information regarding the type of bone change that was found in the ten patients.

CONCLUSIONS

Marked protrusion of one eyeball may occur in tumors in the anterior cranial fossa which have perforated into the orbital cavity, or in growths which are situated in the middle or in both the anterior and the middle fossæ. Unilateral exophthalmos does not occur in frontal lobe growths unless they have penetrated into the orbit through the bone, or unless part of the bony walls of the orbital cavity have undergone a hyperostotic change and the thickened bone occupies space within the orbit. The main growth may, however, be situated in the anterior cranial fossa although much of the hyperostosis involves the bone in the middle fossa. Theoretically, at least, a growth may be in the frontal lobe but a localized increase of pressure in the middle fossa may be sufficient to bring about a prominence of the corresponding eyeball.

In tumors in the middle cranial fossa, on the other hand, the growth may extend into the orbit through the superior orbital fissure or the neoplasm or a hyperostosis associated with it, may produce an increase of pressure in the middle fossa which is transmitted to the orbital cavity. The superior orbital fissure may be enlarged as the result of bone destruction, and its margins may be much thickened. The superior and posterior portions of the orbital cavity are most frequently encroached upon. Venous stasis may also occur, but it is rarely, if ever, the actual or main cause of the protrusion of the eyeball. Unilateral exophthalmos is frequent in the frontal or temporal lobe meningiomata with large cranial hyperostoses, but it may be produced by other varieties of intracranial neoplasm..

For a period of years an exophthalmos and a small hyperostosis may be the only signs of a serious intracranial lesion, and there is often a long delay before the condition is recognized and the patient referred to the surgeon. The patient himself may procrastinate or be unwilling to submit to a cranial operation because of the absence or the paucity of symptoms. A combination of circumstances may therefore bring it about that surgical aid is invoked when the exophthalmos has already become very marked or the cranial hyperostosis very deforming—at a period when the intracranial neoplasm is of large size.

The results of surgical therapy would have been better if many of our patients had been operated upon earlier, and in most of them the technical difficulties encountered during the surgical procedures would have been less if the neoplastic disease had not been so far advanced.

In the absence of demonstrable disease in the orbit or the neighboring air sinuses, a slowly increasing unilateral exophthalmos may be, therefore, an important sign of an intracranial lesion expanding in nature. It is not at all necessary that the patient shall have other symptoms or signs of a brain tumor. The protrusion of the one eyeball may occur without any other evidence of disease, or the X-rays may demonstrate a hyperostosis in the anterior or middle cranial fossa, or evidence of destruction of part of the walls of the orbit.

SUMMARY

1. In a series of 807 intracranial tumors, marked unilateral exophthalmos was observed in 15 patients.

2. Most of the tumors were meningeal fibroblastomata, but exophthalmos occurred also in a case of primary carcinoma of a sweat gland of the scalp, in an epidermoid in the middle cranial fossa, in 2 cases of orbito-ethmoidal osteoma, and in a case of Paget's disease with intracranial complications.

3. Unilateral exophthalmos may also occur in metastatic carcinoma and venous and arteriovenous angiomata.

4. The protrusion of one eyeball was often, for a number of years, the only symptom.

5. The exophthalmos was most frequently on the left side in females and on the right side in males.

6. In many of the patients there was also a cranial hyperostosis—visible when on the vertex and demonstrable by X-rays when on the base.

7. The protrusion of the eyeball was most often due to perforation of the tumor into the orbit, thickening of the orbital walls, extension of the growth through an enlarged superior orbital fissure, or increase of pressure in the middle cranial fossa directly transmitted to the orbital contents through the superior orbital fissure.

8. There was no positive evidence in any of the patients that the unilateral exophthalmos was the result of compression of the cavernous sinus or the ophthalmic veins and venous stasis.

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HICCUP[1]

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TO those who have never observed or been called on to treat certain types of hiccup, a consideration of the subject may seem trivial. To me it has been fascinating, not only because of its importance, which no patient who has had it would deny, but because in some of its various forms it is peculiarly resistant to the numerous usual lines of treatment instituted to control it. This paper has for its purpose a review of the subject up to the present, a presentation of a classification of hiccup, exposition of a system of treatment, with emphasis particularly on the etiology and treatment of persistent hiccup as a postoperative complication.

The amount of knowledge on any subject such as this can be considered as being in inverse proportion to the number of different treatments suggested and tried for it. Perhaps one is justified in saying that there is no disease which has had more forms of treatment and fewer results from treatment than has persistent hiccup.

HISTORICAL ASPECTS

Historically the subject of hiccup is old. References to it go back hundreds of years, both in non-medical and in medical literature. Treatments were multiple and varied. Pliny suggested fifteen or sixteen "cures." During the medieval period Paulus Aegineta discussed the subject from the standpoints of etiology and treatment. "Fullness of the stomach," the presence of "acrid or pungent humours in the stomach," and "rigors" (chills) were the causes he recognized, and his treatment he based on reason. When the stomach was distended, or "spoiled food" was found in it, the stomach was emptied by emetics and strong evacuation was brought about. Evacuation was assisted by sneezing. "When the stomach is empty sneezing will not cure it." When hiccup was present and the stomach empty, Aegineta suggested "rue with wine or nitre in honeyed water or hartwort, or carrot, or cumin, or ginger, or calamint or celtic nard." "Retaining the breath is likewise of great use," he asserted.

Galen dismissed hiccup, saying that it was occasioned by an exciting cause which aroused the stomach to violent emotions, and sneezing proved a cure to it. Celsus felt that frequent and unusual hiccup was symptomatic of an inflamed liver. Aetius stated that singultus in fevers often arises from inflammation of the stomach and neighboring parts. When it was caused by "pungent humors" he gave an emetic, then narcotics such as opium, and in severe cases applied cupping instruments, with great heat, to the breast, stomach, and back. The Arabians and the Methodist school of medicine also agreed that the cause of hiccup was inflammation of the stomach.

In a book entitled *A Thousand Notable Things of Sundrie Sortes*, by Thomas Lupton, published in London in 1627, is found the following, referring to hiccup: "stop both your ears with your fingers and the hickop (hiccup) will go away within a while after. Proved." And later, "It is proved and a secret: that if you give to them that have a hickop (hiccup) every morning three hours before meate one roote of green ginger and immediately after drinking two draughts of Malmesey, you shall see that he will become cured."

Dr. Shortt, of Edinburgh, in 1833, is recognized as the first to have called attention to the relationship between the phrenic nerve and hiccup. He recommended blistering the surface of the neck over the course and origin of the phrenic nerves in the treatment of intractable hiccup.

There are few people who have not at some time or other had hiccup of some type and a description of the condition is consequently unnecessary. Its treatment, however, in many instances, is today as much a problem as ever and it seems justifiable to attempt to discuss and suggest lines of thought and lines of treatment in connection with the subject.

[1] Read before the Reading Hospital General Staff, Reading, Pennsylvania, April 15; before the George Washington Medical Society, Washington, D. C., April 16; and before the Norfolk County Medical Society, Norfolk, Virginia, April 18, 1932.

CLASSIFICATION

To be of value a classification must have two requisites; it must be applicable and must be simple. A classification of disease is best made on an etiological basis, for if treatment is to be other than "hit or miss" it must be directed intelligently toward the cause or causes.

It will be noted in the classification which follows, the first group is headed "Infectious persistent hiccup." I am well aware of the fact that in using the adjective "infectious" I bring up a matter which may be debatable, inasmuch as there are those who do not believe that afflictions such as epidemic hiccup should be so classified. I do not feel qualified to argue the question from a bacteriological standpoint, but from a clinical standpoint the term seems justifiable. Although our bacteriological studies on postoperative persistent hiccup are not yet complete, the evidence at the present time would indicate that in this group the word "infectious" is also correctly used.

- Infectious persistent hiccup (usually central)
  - Epidemic
  - Postoperative
- Chemical hiccup
  - Central (this is of questionable existence)
  - Peripheral (reflex from chemical irritation of the stomach, intestine, diaphragm or of some structure of the same somatic segment as the diaphragm)
- Mechanical hiccup (reflex from pressure)
  - Central
    - Tumor
    - Vascular disturbance
  - Peripheral
    - Stomach
      - Rapid dilation
      - Slow dilation of long duration
    - Tumor (irritation of diaphragm or of reflex arc that involves phrenic nerves)
      - Neoplastic
      - Inflammatory
    - Vascular disturbance
- Hysterical or psychic hiccup
- Indeterminate hiccup

TREATMENT IN GENERAL

It is difficult in many cases to determine the cause of hiccup. Particularly is this true after operation, when the picture is masked by the effects of the surgery. Thus, it may be necessary to assume a definite cause and to treat accordingly. For example, if a man 40 years of age or more develops hiccup within 3 weeks after operation, the ordinary methods of treatment should be tried. One of these is lavage. Another, which also aids in ruling out gastric dilation and chemical irritation of the gastric mucosa is the administration of soda water. If these methods of treatment, and if narcotics and sedatives give but temporary relief, then it is fair to assume that the cause is central infection and to give encephalitic antistreptococcus serum, sedatives and other means being used to give temporary relief until the effect of the serum has an opportunity to manifest itself. If, again, the assumption of the cause has been correct, then the effect should be noted in most cases within a few hours.

TREATMENT OF INFECTIOUS PERSISTENT HICCUP

It is my impression that a vast majority of cases of the persistent type of hiccup are caused by a specific organism. This belief is supported by numerous cases studied and reported by Rosenow with particular reference to epidemic hiccup; also, by the studies of Rosendaal and me in relation to postoperative hiccup. Occasionally persistent hiccup may come from other causes than specific infection (if so it may be possible to classify it as of the hysterical or mechanical type).

Epidemic form. The evidence points toward the conclusion that epidemic hiccup is caused by a specific organism. The disease is exhausting because of its tenacity, respecting neither night nor day, patient nor physician, usual medication nor prayers. It may last for a few days, weeks, or even months, but fortunately contagion is not usually demonstrable.

The work of Rosenow is outstanding in this connection, and I can best consider the condition by briefly summarizing his work. Epidemic hiccup is closely related to epidemic encephalitis. The two diseases frequently occur together in the same locality at the same time and occasionally affect the same patient. Bacteriologically, there is also a close relationship. Rosenow, by repeated passage of the organism through animals, has demonstrated

a change in the character of symptoms produced, from that of hiccup to those of lethargic encephalitis. He felt that a change in tropism or localizing power on the part of the organism during repeated animal passage explained this phenomenon.

The causative organism isolated from patients suffering from epidemic hiccup is a neurogenic type of streptococcus in short chains (Streptococcus singultus). It may be obtained from the throat and also from the urine and blood. The organism, likewise, has been isolated from the brain and spinal fluid of inoculated animals in which hiccup developed. It is gram positive, not encapsulated, produces greenish colonies on blood agar plates, and grows in short chains in liquid medium. In glucose-brain broth the growth is rapid and diffuse, and aerobic cultivation destroys its specificity.

In animals, the pathological findings do not appear to concern the phrenic nerves directly; rather are they confined to the basal ganglions, to the walls of the ventricles, and to the gray matter of the cortex and medulla, in varying extent. Microscopically may be seen circumscribed areas of hæmorrhagic necrosis, and infiltration with leucocytes and round cells especially about blood vessels. In acute lesions bacteria may be found.

The symptoms and lesions produced in animals by injections of active filtrates, and of suspensions of dead bacteria and of living bacteria are essentially alike according to Rosenow. Symptoms of shortest duration follow injection of filtrates; those of longest duration follow injection of living bacteria. "The localizing power of this streptococcus consequently would seem to be due to a chemical substance produced either by the streptococcus or during the reaction incited in the host." The treatment of epidemic hiccup is considered together with that of persistent postoperative hiccup.

Postoperative form. It seemed to me that perhaps many of the cases of persistent postoperative hiccup might be due to a specific organism, as in epidemic hiccup. Following this hypothesis, and reviewing cases, many interesting facts came to light, some of which might be worthy of note.

The condition has affected, as far as I have observed, men only; for the most part, men of more than 45 years of age, the average being 54.5 years. It may follow major operations on the colon, the urinary tract (especially the prostate gland and the bladder), the gall bladder, the stomach, and occasionally other structures. If the cases which followed gastric surgery be omitted, the shortest duration of the hiccup was 4 days; the longest, 27 days; the average, 9.7 days.

This type of hiccup, which is persistent and which comes on after operation seems to run a definite course, varying only in intensity and duration; the course is such as might be run by any infectious disease. In the early and late part of its progress it is amenable to symptomatic treatment, from which temporary relief may be expected. At its height, however, no measures for relief that are directed against symptoms have any appreciable value, except radical steps such as bilateral phreniclasis or phrenicotomy. These measures are extreme and should not be adopted except as last resorts.

The onset of this unfortunate complication may be on any day after operation, but usually some time between the first and the seventh days. The condition is not seen in any one season; however, there is a greater incidence between and including the months of November and April.

On the basis that I have known a 16 day attack of hiccup to follow prostatic massage, that I have seen only males affected, and that a large majority were more than 45 years of age, that in those surgical cases in which the condition did occur as a complication, usually there were also urinary symptoms present or there had been disturbance of the prostate gland such as required repeated catheterization or an indwelling catheter, I have the hypothesis that the primary focus of the infection is the prostate gland. Not that all prostate glands harbor the specific organism, but certain men are potential victims of the infection, given the proper condition.

On the assumption, then, that persistent postoperative hiccup might be caused by a specific organism, Rosendaal and I made a clinical and bacteriological study of several

cases which came under our observation, and we were able to recover from throat swabs a neurogenic type of streptococcus, which, inoculated into animals, produced spasms of the diaphragm. A further report of these experiments is being prepared.

That there is a relationship between the organisms of epidemic encephalitis and of epidemic hiccup is fortunate, because the encephalitis antibody globulin solution as prepared by Rosenow can be applied in treatment. Such treatment was given in those of our cases in which persistent hiccup was present, and we were able to recover the neurogenic streptococcus from the throat and reproduce spasms in animals. The effect of the serum was dramatic in many instances, all symptoms of hiccup disappearing within a few hours.

There are, then, three lines of treatment to follow in cases of epidemic and postoperative infectious persistent hiccup: (1) specific treatment, which is aimed at the cause; (2) symptomatic treatment; and (3) general treatment.

For specific treatment encephalitic antibody globulin solution is administered. First the patient is tested for hypersensitiveness to horse serum, by injecting not more than 0.05 cubic centimeter of the serum subcutaneously. If no urticarial wheal, associated with itching, develops in 20 minutes the therapeutic injection may be given. If the patient is sensitive, desensitization should be carried out by giving from 4 to 6 subcutaneous injections at intervals of half to one hour in doses increasing from 0.1 to 1.0 cubic centimeter. If no reaction occurs following these injections, the first therapeutic dose may be given. In acute cases of epidemic or persistent postoperative infectious hiccup, 2 to 5 cubic centimeters of the serum should be given twice or thrice daily for 2 or 3 days, depending on the age of the patient, on the acuteness of the symptoms, and on the results obtained. These injections are to be given intramuscularly and should be followed by massage to facilitate absorption.

I have found that in most instances the hiccup in these cases is controlled in an hour to 4 hours after the first dose, and consequently have not found it necessary in many cases to give more than two doses. As with other solutions in which horse serum is the base, occasionally on or about the seventh day after injection an itching dermatitis may develop. None of these sequelæ has been serious, and the patient can be kept comfortable with calamine lotion and other substances containing phenol.

Symptomatic treatment is a reasonable procedure to follow during the entire course of hiccup. Its object is to lower tonicity of nerves and muscles. If the case is of a truly infectious type, nothing more can be expected from this treatment. It applies mainly to the diaphragm, phrenic nerves, and brain. The substances used are as follows: morphine sulphate, with or without atropine; codeine, with or without atropine; camphorated tincture of opium; barbiturates given by mouth or intravenously (sodium *iso*amylethyl barbiturate known as sodium amytal, or pentobarbital sodium); bromides; phenobarbital (luminal); barbital (veronal); the mixture of allylisapropyl barbituric acid and aminopyrine (allonal); chloral; chlorbutanol (chloretone); quinine (3); carbon dioxide and oxygen by inhalation; anæsthesia by inhalation; rest and quiet.

Carbon dioxide alone is dangerous; consequently, tanks containing the proper mixture are advantageous. Such tanks contain carbon dioxide combined with oxygen 5 to 10 per cent. A simple and more fool-proof method is rebreathing from a mask and rubber bag; even a paper sack may be used. These methods should not be applied for more than 15 minutes at a time.

Self anæsthesia is occasionally advantageous and if used should be carried out with the patient in a sitting position and with no arm rest. Ether or chloroform is poured on a piece of gauze and held to the nose by the patient. When a sufficient amount has been inhaled, the patient removes it himself, or relaxing the unsupported arm cuts off further dosage.

It may be that more than one factor enters into the cause of hiccup. Therefore it is essential to consider the case from other angles than that of infection, even though the case may fulfill the requirements for the conclusion that it is of infectious origin.

General treatment consists of measures which tend to build up bodily resistance. It

may be necessary to combat dehydration, to control diabetes, to support a deficient heart, to increase output of fluid, to improve elimination in other ways, to build up a carbohydrate reserve, and to treat anæmia. Many possibilities are to be considered, and each case is a problem unto itself.

TREATMENT OF CHEMICAL HICCUP

As a group, this type is somewhat difficult to define. It contains particularly those cases of hiccup caused by ingestion of highly irritating foods or liquids, and it is generally of comparatively brief duration. The chemical factor may be combined with a mechanical one. Particularly is this true when hiccup follows gastric operations. For a few days, swelling and œdema may interfere with gastric motility, and the outlet or outlets, new or old, may function badly. Gastric secretion and old blood may be retained and become rancid, creating chemical irritation and causing or being a contributary cause to reflex hiccup.

It is in the group of chemical hiccup that alcoholic hiccup falls, and those cases referred to by Paulus Aegineta when he stated "many people hiccup when the food spoils on the stomach."

Treatment must consist in removal of the cause, which is best accomplished by emptying the stomach, keeping it empty if the content cannot pass through, or, if the outlet of the stomach is patent, aiding in rapid passage through the intestinal tract what has not been vomited or washed out with a stomach tube. To accomplish this, large doses of a bland oil are better than an irritating cathartic. Copious enemas also induce greater peristalsis and aid in elimination.

The following measures might be classed as specific treatment: gastric lavage, single, repeated, or constant, such as can be effected through an indwelling, nasal Refuss tube; administration of emetics, such as apomorphine; giving of large doses of hot water, soda water, mustard, and so forth; administration of laxatives rather than cathartics; administration of enemas, which may contain turpentine, and administration of pituitrin. Of the last substance, a surgical ampul is given in divided doses, either with an enema or alone.

Symptomatic treatment may be necessary. It should not interfere with treatment aimed at the cause. After the causative agent has been eliminated, treatment should be directed at the hiccup itself, it being remembered that if the hiccup continues after repeated lavage, the cause of the irritation still remains and must be properly treated. One is likely to forget this, and to begin dribbling into the stomach in repeated doses such additional irritants as Hoffman's anodyne, and chloroform and sugar. These temporarily anæsthetize the nerve receptors, but they tend to aggravate the condition or to prolong the course of the hiccup when the numbing effect has worn off. After specific treatment has been carried out, and in cases in which a mechanical factor is not present, one or more of the following substances or methods may be used:

Repeated small doses of sodium bicarbonate, or a similar mildly alkaline substance in water; olive oil in small doses (or mineral oil); barbital (veronal) in warm milk; ice cream; sips of warm water; soft diet, no harsh foods for a few days; as few drugs as possible, and sprays to the throat of a 2 per cent solution of cocaine, followed by application of 20 per cent cocaine to the larynx by indirect laryngoscopy. Any solution of cocaine so applied must be freshly prepared to be entirely safe. Again, by indirect laryngoscopy, about 1 cubic centimeter of 4 per cent cocaine in a laryngeal syringe is instilled, drop by drop, between the vocal cords into the trachea. By the same method warm plain albolene is then dropped into the larynx and trachea. Treatment by spray and direct application such as this, repeated once a day for a few days, has been reported to give temporary relief. The rationale is that cocaine abolishes the afferent source of reflex irritation via the vagus nerves, the efferent path being, of course, through the phrenic nerves (4).

It is within the realm of reason to suppose that the chemical change produced in cells by inflammatory reaction near the diaphragm, or for that matter in any part of the reflex arc concerned with hiccup, may be the inciting cause of the phenomena. Clinically, such a cause may be difficult to determine; for the

most part the inciting condition is subdiaphragmatic abscess, supradiaphragmatic abscess, or other inflammatory condition situated contiguous to the diaphragm; the source of irritation may be distant, but segmental. Here medical or surgical skill is called for, as the individual case may indicate.

Elkin has reported a case of direct reflex hiccup. The patient was a negro aged 28 years, who 8 days prior to the time that Elkin saw him had received a stab wound in the left trapezius muscle. The fourth day after the injury he began to hiccup. The tissue about the stab wound was fluctuant, and on being opened was found to contain about 15 cubic centimeters of pus. Fluoroscopic examination of the thorax gave evidence of paroxysmal contractions of the diaphragm, occurring about ten times each minute. Phenobarbital (luminal), bromides, chloral, sodium isoamylethyl barbiturate (sodium amytal) and morphine were given for 3 days without effect. On the seventh day of hiccup, the left phrenic nerve was crushed, and hiccup ceased within 30 minutes, returned for 20 minutes the following day, and from then on recovery was uneventful.

TREATMENT OF MECHANICAL HICCUP

The structures concerned with the reflex arc may be excited by mechanical means, such as pressure.

Central form. Among central causes are tumors of the brain, which may result in direct pressure because of their position, or they may result in secondary pressure. If the pressure is direct, operation may be directed at the tumor itself, or decompression may be directed at relieving the pressure, or symptomatic treatment may be directed at the hiccup itself, the cause being disregarded. If secondary pressure from tumor of the brain is considered to be an etiological factor in hiccup of central origin, the following treatments, which involve the use of hypertonic solutions, should be considered: glucose, in 10 or 20 per cent solution, given intravenously; magnesium sulphate in retention enemas; hypertonic cathartics of which the action is based on the principle of drawing fluid into the intestinal tract, and spinal puncture. Symptomatic treatment can also be carried out as described.

Another class of central causes is vascular disturbances, either within the brain, or concerned with the blood supply of the brain, particularly the brain stem. These vascular abnormalities may directly interfere with the hiccup center, which presumably is in the brain stem near the respiratory center. They may interfere, secondarily, with that center as a result of increased intracranial pressure.

Treatment is rarely surgical, and is usually confined to symptomatic measures and to relief of pressure by use of hypertonic solutions, as suggested. It is well to remember also that it is possible to have, as the primary cause of hiccup and vascular disturbance, the presence of the Streptococcus singultus as has been demonstrated by Rosenow (16) in a report of a case of thrombosis of the cerebellar and vertebral arteries associated with intermittent hiccup. Rosenow was able to recover the streptococcus from the throat and urine during life, and from the blood stream after death, and to reproduce the spasm and evidence of central localization in animals.

Peripheral form. The first subgroup under this type has to do with disturbance of the stomach. Rapid gastric dilation as a cause of hiccup is illustrated by the hiccup which afflicts infants. Their small, young stomachs are rapidly filled to more than normal capacity, and hiccup is a not infrequent occurrence. The mother or nurse has to balance the child just so over the shoulder to "get up the bubble," a procedure usually accompanied by partial return of ingested milk. Physiologically, the spasms may aid in the forcing of stomach content through the pylorus and into the small intestine by the downward force of the diaphragm and the spontaneous tightening of the abdominal muscles.

Rapid dilation, also, accounts for hiccup which follows heavy meals taken by adults. In fact, most of the so-called simple hiccup of short duration is caused by rapid dilation, and methods most efficacious in treatment are those which empty the stomach, either removing the content from above or aiding in forcing the content into the small intestine. Thus, hiccup of this sort will eventually cure itself, but it is uncomfortable, and means are at hand to hurry the procedure. It is best to begin

with simple measures in most instances. These are: having the patient inspire and hold the breath, or blow into a bottle, or drink water while holding the breath; giving bicarbonate of soda or similar substances in solution; exerting traction on the tongue for 2 minutes; inducing sneezing by tickling the nose with a feather; lowering the head and dilating the anus; causing the patient to sip hot or cold water or hold ice in the mouth; giving sudden shock by taking the patient unawares with a loud noise; telling the patient to stand on the hands or the head, or to drink lemon juice and salt, or to take a teaspoonful of vinegar and sugar; flexing the legs of the patient on the thighs and the thighs on the abdomen; putting a compress of ice on the epigastrium; with the patient's arms vertical, directing him to open the mouth wide and to extend the tongue; causing the patient to concentrate on the effort to put the points of two pins together; compressing the eyeballs (5); exerting pressure over the fifth cervical vertebra; giving atropine or belladonna to relax the pyloric sphincter; inducing vomiting by tickling the throat; employing gastric lavage; and administration of emetics such as apomorphine.

It is possible that hiccup from rapid gastric dilation may be an additional symptom in a complex condition for which surgery is required; in such a case, of course, surgery dispels the symptom.

Slow gastric dilation as a cause of hiccup is more difficult to treat. Chronic obstruction, obstipation, and asthenia with lack of tonus in the intestinal tract are the principle causes. Surgery may also be indicated in this type of case to relieve obstruction. Medically, patients should be treated to bring back intestinal tonus, and to correct constipation by proper diet and well directed medication; frequently anæmia is part of the picture, and tonics can be given with benefit.

A large, toneless stomach can sometimes be reduced in size by keeping it empty for a number of days, giving repeated lavage, and in the meantime supplying fluids by proctoclysis, or by subcutaneous or intravenous injection.

The second subgroup of mechanical peripheral causes of hiccup is concerned with disturbances caused by tumors. Neoplastic or inflammatory growths, may, by direct contact with peripheral structures concerned with the reflex system of hiccup, cause the phenomena under consideration. Roentgen rays are the chief means of determining the presence of tumor when clinical evidence fails. In one case which came under my observation and in which cholecystectomy and appendectomy had been done, hiccup for 9 days ensued. Roentgenograms of the thorax revealed a large mediastinal tumor, and although a therapeutic test was not made in this case, it was assumed that the cause of the hiccup was mechanical, because of the proximity of the mass to the phrenic nerves.

Treatment is surgical when possible and is directed at the growth. Either roentgen rays, radium, or both, is the next choice. In the meantime, symptomatic treatment must be instituted, as previously has been said. If the hiccup continues, the decision may have to be to operate directly on the phrenic nerves. If a neoplastic growth is the cause, phrenic neurectomy, with avulsion of the nerve, is the procedure of choice.

The third subgroup of mechanical peripheral causes of hiccup has to do with vascular disturbances. Aortic aneurism occasionally may produce hiccup. If persistent, operation on the phrenic nerves may be indicated; otherwise treatment in these cases should be symptomatic.

TREATMENT OF HYSTERICAL OR PSYCHIC HICCUP

It has been wisely said that within the realm of hysteria all conditions may be simulated. Thus, we may be led far astray in the search for a cause of hiccup when such an etiological factor lies at the base of it. We do have, however, certain points which may give leads. The condition is most common among young women between 18 and 35 years of age. It is rare among men; no cases have been reported. The affected patients have a predisposition to hysterical manifestations, and are likely to be of inferior nervous makeup.

This type of hiccup may be of brief duration, but more commonly it is persistent, and it may last days, weeks, or months. Treat-

ment, of course, should be such as will have a psychological effect. The condition is caused by suggestion which may be subconscious, and it may be cured by persuasion. The type of persuasion depends on the individual case, and varies from mild to almost inhumane methods. The mental basis for the hiccup should be determined if possible. Then the following may be tried: reasoning, which is rarely successful; contrast baths; continued administration of sedatives in large doses but no opiates unless necessary; emetics, particularly apomorphine by hypodermic injection; repeated lavage, large tubes being used; anæsthesia; indirect tracheal intubation, the tube being left in place several hours; and phreniclasis.

A typical case of hysterical hiccup of a girl of 23 years was reported by New. Hiccup that had lasted intermittently for months was cured permanently by two intubations with an O'Dwyer tube of large size. The tube was left in place the last time for 8 hours.

TREATMENT OF INDETERMINATE HICCUP

In this group are included those cases which cannot be justifiably placed in any of the other groups. It is the hope that it will prove to be a small group and will grow smaller as cases of hiccup are more closely analyzed. Treatment here is necessarily of a blind type. Should the hiccup be persistent, the known specific treatments for cases in the other groups should be tried. For example, encephalitic antistreptococcus serum, or encephalitic antibody globulin solution should be given. If all such measures fail, operation on the phrenic nerves must be considered.

SURGERY DIRECTED AT CUTTING THE REFLEX ARC

Surgical procedures on the phrenic nerves to control hiccup, attack the symptom but not the cause. Consequently such a method should not be resorted to until all others have failed. Undoubtedly there is a place for phrenic neurectomy, avulsion of the phrenic nerves, and phreniclasis. It may be noted in the literature that such surgical measures have been taken after several days of hiccup.

The following considerations should be thought of before operation is attempted: most cases of persistent hiccup, epidemic or postoperative, among men, are on basis of infection with a specific organism. If specific treatment has not been applied it should be remembered that like most other infectious conditions, infectious hiccup runs a definite course, varying only in severity and duration. On an average, 9½ days is the duration of hiccup as a postoperative complication. The longest duration of which I know was 27 days. Operation means additional trauma to already well exhausted patients. However, operation on the phrenic nerves to control hiccup may be advisedly done in some cases. It must be based on evaluation of previous treatment, on one's being convinced that the condition has not about run its course and is ready to stop spontaneously, and on thorough consideration of the individual patient from the angles of physical and mental depression and exhaustion. If other methods have failed, and the hiccup has lasted for weeks, phreniclasis, as described by Egan is the surgical procedure of choice. If, on the other hand, hiccup has lasted months, phrenicectomy or phrenic avulsion is perhaps the best method of control. Crushing or cutting the left phrenic nerve may only decrease the severity of the condition, but will not eliminate hiccup unless it is ready to stop spontaneously. Thus, this measure may falsely be considered curative.

THE POSSIBILITY OF AUTOVACCINATION

The following cases I am reporting in more detail to illustrate the possibility of autovaccination in hiccup.

CASE 1. A man, aged 60 years, underwent extravesical excision of bladder diverticula, June 25, 1929. The second day after operation hiccup began. At first it was easily but temporarily controlled by ordinary methods. As time wore on the complication became more severe (graded 4), and was no longer controlled at all well. Sodium isoamylethyl barbiturate (sodium amytal) in doses of 5 grains required 1 hour to take effect, and gave relief for 2 hours at most. Morphine and codeine were the other drugs which in comparatively large doses could be counted on to give temporary relief. Carbon dioxide gave relief at the height of the hiccup, but only for 20 minutes. The postoperative convalescence as a whole was stormy, the temperature ranging from 100 to 102.5 degrees F. for a number of days, and the average pulse rate was 95 beats each minute. The duration of the hiccup was 8 days.

Three months later to the day, suprapubic prostatectomy was performed. The postoperative course was uneventful and no indication of hiccup was present at any time.

CASE 2. A man, aged 45 years, had undergone gastro-enterostomy elsewhere in 1909, following which he had retention hiccup for a day, that was relieved by lavage. In 1913 entero-anastomosis was performed at the clinic and uneventful convalescence ensued, with no hiccup. In May of 1931, cholecystectomy and closure of a cholecystogastric fistula was done. The evening of the day of operation hiccup began, which was temporarily controlled by inhalations of carbon dioxide and drinking of soda water. He obtained best relief by merely keeping quiet. The hiccup lasted more than 6 days; severity was graded 2 on a basis of 4. One month afterward, repair of a unilateral inguinal hernia was done, and 2 or 3 days later mild hiccup developed, which could be graded at less than 1 in severity and which lasted only 2 days.

It will be noted that in the cases reported the first patient had severe hiccup, the second, a much milder case. The first patient did not have recurrence following the next operation, 3 months later. The second patient had very mild recurrence of hiccup after his operation for hernia, which was done a month after the operation which had involved the upper part of the abdomen.

In the files of the clinic also are records of cases in which hiccup developed, although no sign of the complication was present following operation on the same patient 2 to 3 months previously. It would seem, then, that the organism lies dormant until such time as either its virulence is increased or the resistance of the patient is so low that an organism that ordinarily is under control becomes virulent. On the other hand, as Rosenow believes, there may be cycles in the life history of these organisms as they exist in nature, and at certain times of the year they are more virulent than at others, and patients are thus infected from outside sources.

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THE ACUTE GALL BLADDER MANIFESTING FEW SIGNS OR SYMPTONS

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ACUTE cholecystic disease is occupying, at the present, a prominent place in medical literature, the major reason probably being the difference of opinion relative to its treatment.

A universal classification of cholecystic disease would simplify the problem. Certain types of acute cholecystitis are treated similarly the world over. Thus, acute catarrhal cholecystitis is never considered a surgical problem, while acute gangrenous cholecystitis necessitates immediate operative care. Our problem lies not in these but in other acute gall-bladder lesions, namely, acute exacerbations of chronic cholecystitis, acute hydrops, acute empyema, necrotic œdema (7), acute phlegmonous cholecystitis, and acute or subacute perforation of the gall bladder. The problem would be still further simplified if we could anticipate the type of acute lesion present, but herein lies much of our difficulty, as this differentiation is often quite impossible. Occasionally the careful diagnostician correctly delineates the pathology present, but often it is impossible to judge the stage of the disease properly. Therefore, it has been considered best to delay surgical intervention until the diagnosis is adequately established and until the acute inflammatory lesion has somewhat subsided. The results of this procedure can be evaluated from the following data.

During the 12 year period between 1919 and 1931, there were 91,495 patients admitted to the San Francisco Hospital, not including those having tonsillectomies. Of these, 23,864 were operated upon, approximately one-fourth. These included 1,614 patients suffering from cholecystic disease; less than one-fourth of these were operated upon. A diagnosis of "acute cholecystitis" was made in 249. After reviewing the histories, I eliminated 115 as not sufficiently acute to be studied in this paper. Therefore, only 134 of the 1,614 gall-bladder entrances were for "acute cholecystitis" (8.2 per cent); approximately 0.56 per cent of the total hospital operative cases or 0.046 per cent of the total hospital admissions, not including the tonsillectomies. In comparison with other acute abdominal lesions, acute cholecystitis was about one-tenth as frequent as acute appendicitis, one-half as frequent as perforated gastric or duodenal ulcers, and twice as frequent as acute intestinal obstruction.

The total cholecystic lesions encountered during the period between 1919 and 1931 were grouped as follows: 93 cases of pericholecystitis, 134 of acute cholecystitis, 630 of chronic cholecystitis, 639 cases of chronic cholelithiasis, and 118 of common duct stone or carcinoma.

The cases of acute cholecystitis are tabulated in Table I. It will be noted that 4 instances of perforation occurred in patients while under medical observation. In none of these was the perforation recognized by the clinicians before death. Furthermore, 4 instances of acute empyema treated medically died of peritonitis. In 1 of these patients peritonitis was recognized and believed to emanate from an acute cholecystitis, but the acute peritoneal reaction was not diagnosed. In the second patient, an acute empyema of the gall bladder had been suspected. In both instances the clinicians awaited localization of the acute inflammatory lesion before calling surgical consultation. In 1 case, the acute cholecystic disease was not suspected; the other patient refused to be operated upon. These errors, of course, cannot be construed as indictments against the physician. They serve as illustrations along with other cases more fully discussed later in this paper, of pathology the severity of which cannot always be evaluated before operation.

A comparison of the medical and surgical mortality further emphasizes the difficulty of recognizing how severe an acute cholecystitis

TABLE I.—TOTAL MORTALITY STATISTICS

Pathology	Medical mortality			Surgical mortality		
	Cases	Cases	Per cent	Cases	Cases	Per cent
Acute cholecystitis	44	4	9	11	2	18
Subacute cholecystitis	11	2	18	4	1	25
Acute hydrops	0			6	0	
Acute empyema	4	4	100	18	3	16
Perforation of gall bladder	4	4	100	20	6	30
Gangrene	0			11	4	36
Total	63	14	56	71	16	25

may be, for many patients were not operated upon as soon as they should have been. In no instance, it seems to me, was surgery instituted too early. No patient, however, was operated upon until at least 24 hours had elapsed since the onset of the acute attack.

There were 44 instances of undifferentiated "acute cholecystitis" not considered surgical and therefore treated medically. Four patients died, a mortality of 9 per cent. Two of the deaths were due to peritonitis arising from gall-bladder pathology more acute than was clinically expected. Autopsies were not performed upon the 2 other patients. On the surgical side in 11 patients with "acute cholecystitis" (i.e., acute exacerbation of chronic cholecystitis) were operated upon and there were 2 deaths, a mortality of 18 per cent. For comparative studies, 41 patients with less severe acute exacerbations of chronic cholecystitis (with or without stones) were treated medically without any deaths while 76 similar patients were operated upon with 3 deaths, a mortality of 4 per cent, an unduly high percentage.

In 11 cases of "subacute cholecystitis" medical treatment was instituted and there were 2 deaths (mortality 18 per cent) while 4 patients were operated upon with 1 death (mortality 25 per cent). In no case in which acute hydrops was diagnosed was medical treatment used but 6 such patients were operated upon without mortality.

There were 4 patients with acute empyema of the gall bladder who were treated medically. All of these patients died. Eighteen patients with acute empyema were operated upon and there were 3 deaths (mortality 16.6 per cent).

Four unrecognized perforations of the gall bladder occurred on the medical service with a mortality of one hundred per cent. Twenty perforated gall bladders were operated upon with 6 deaths (mortality 30 per cent).

In 1 instance of gangrenous cholecystitis secondary to carcinoma of the bile duct the patient died on the medical service. Twelve patients with diffuse or local gangrene were operated upon with 4 deaths, a mortality of 33 per cent. Eleven of the 42 patients operated upon for advanced, acute cholecystitis died, a total mortality of 25.6 per cent. All the deaths were due to peritonitis except in 1 patient who had an acute empyema of the gall bladder and died on the twelfth day after operation of parotitis and one who had a perforated gall bladder and died of pneumonia on the fourteenth day. The postoperative interval before death furnishes some concept of the seriousness of delay before surgery, for practically all of the patients died of advanced peritonitis. One patient with a perforated gall bladder died a few hours after operation from peritonitis and shock; 1 with gangrene and 1 a perforated case, each died the first day after operation of peritonitis; 1 with acute empyema, 1 with acute gangrene, and 1 with perforation died the second day; 1, a perforated case, died the fourth day; 1 with gangrene died the fifth day; and 1 patient with a perforated gall bladder died on the fourteenth day of peritonitis. In most of these instances the peritonitis was fairly well advanced before the patient was operated upon.

It is evident from a perusal of this data that the severer grades of acute cholecystitis carry very high mortalities. Furthermore, what appears to be a mild or moderately severe cholecystic inflammation clinically may actually be fulminant. Though the operative mortality in advanced acute cholecystitis is great, it is considerably less than that which followed deferred or mistaken diagnoses. It is true that this statistical study is not large but it furnishes sufficient data for us to reconsider our methods of treatment in this disease. My point, and I cannot make it too earnestly, is that advanced acute cholecystitis cannot be recog-

TABLE II.—AGE AND SEX

Ages	Total	Males	Females
20–25	4	1	3
26–30	2		2
31–35	3		3
36–40	3	2	1
41–45	3	2	1
46–50	9	2	7
51–55	2		2
56–60	4	1	3
61–65	3	2	1
66–70	5	3	2
71–75	2	1	1
76–80		2	
81–85	1	1	
Total	43	17	26

nized in many instances even by the ablest physicians. Therefore, it seems to me that operative intervention should be undertaken earlier in every doubtful case. The statistics of other authors show that the operative mortality of acute cholecystitis need not be high (2, 4, 5, 6, 8, 10). Our own data indicates that we are probably too conservative in our treatment of this disease. Inasmuch as the surgeon is called in consultation by the clinician, I am making a plea, which is based upon these figures, for earlier surgical consultation.

A more detailed study of the severest cases may enhance our problem. From the series of 134 cases of acute cholecystitis, I have taken 43 consecutive operative cases of perforation, gangrene, or acute empyema for further consideration. There were 17 males and 26 females, ranging from 20 to 85 years of age as shown in Table II. The greatest number occurred between the ages of 45 and 50, although there was a surprisingly high percentage in the decade between 60 and 70. Two moderately severe instances of acute gangrenous cholecystitis developed in young persons aged 23 and 25.

TABLE III.—SYMPTOMATOLOGY

Time	Duration of chronic symptoms				Duration of second			
	Colic	Indigestion	Vague	Jaundice	Acute symptoms		Acute attack	
Denied	6	5			None	1		
1–3 mos.	2	2			Few hr.	0		
4–6 mos.	4	2		1	12 hr.	1		
7–12 mos.	1	1			1 day	8	1	
1–2 yrs.	5				1–3 days	9	4	
2–4 yrs.	3	4		1	4–6 days	11	1	
4–6 yrs.	6		1		1–2 wks.	3		
6–10 yrs.	2				2–3 wks.			
Over 10 yrs.	2	1			More 3 wks.	1		

Acute symptoms. Six of the 43 patients denied ever having had stomach distress of any sort. Two had had distress of less than 3 months' duration; the 35 remaining patients gave a history of suggestive or typical gall-bladder disease over relatively long periods of time (Table III). Only 2 of the patients, however, had been previously jaundiced.

Acute symptoms were denied by 1 patient; he maintained he had had no distress even immediately before surgery was instituted. Another elderly patient was under observation for 35 days in the hospital following two operative procedures for prostatic obstruction when he suddenly developed acute abdominal pain with marked physical signs of some abdominal catastrophe. Within a few hours he was operated upon with a tentative diagnosis of mesenteric thrombosis but a ruptured gall bladder was found. He must have had considerable pathology in his gall bladder long before perforation occurred, yet he gave no indication of any gall bladder disease in his history or during his 35 days in the hospital. One patient was operated upon for a strangulated femoral hernia; the hernia was present but not incarcerated. A ruptured gall bladder caused the acute abdominal symptoms. One patient was operated upon for a ruptured ulcer. His previous history was quite typical of chronic duodenal ulcer, but at operation an early gangrene of the gall bladder was found but no peptic ulcer. Only 1 patient had a history of acute onset 12 hours before exploration was instituted. This pa-

TABLE IV.—PHYSICAL SIGNS

	Pain	Indigestion	Vomiting	Tenderness	Rigidity	Jaundice
Denied	2	5	11	3	2	30
Grade I	4	10	8	5	6	3
Grade II	17	15	17	16	15	5
Grade III	9	1	5	16	12	1
Grade IV (colic)	5	3	0	1	1	0
Required M. S.	5					

tient recovered. Eight patients had distress for 1 day or less, and 1 patient had an exacerbation of acute cholecystic signs for 1 day before operation was performed. The majority of the patients were observed from 1 to 6 days before operation was undertaken. This is in accord, of course, with the teaching at most medical schools of conservation in the treatment of acute cholecystitis. Five patients were under observation between 2 and 3 weeks before surgery was performed. Six of the patients passed through one acute attack only to have a second a few days later; the majority of these occurred within a few days and probably therefore represent exacerbations of the same pathology.

A study of Tables IV, V, and VI is pertinent for it further indicates how advanced the pathology of acute cholecystitis may be before adequate signs are present for its recognition. Eleven of the 20 cases of ruptured gall bladders were kept under observation from 5 to 19 days before surgery was performed. Nine of these were observed for 11 days or more. This data is all the more significant when we remember that these patients were in a teaching hospital where several of the staff were in attendance. Even so, the pathology had advanced far beyond the clinical appreciation of the state of the disease. The point I am trying to emphasize is that even when we may be anticipating advanced pathology, it can be present without recognition.

Pain. An analysis of the symptomatology is rather surprising, for the distress caused by these advanced lesions did not seem commensurate in many instances with the degree of pathology present (Table IV). Two patients denied abdominal pain or discomfort. One of these had a ruptured gall bladder with peritonitis which caused her death; the other had a gangrenous gall bladder. Four patients had mild or indefinitely located discomfort; 2 of these had ruptured gall bladders; 1 had an acute empyema and 1 had a large œdematous and acutely inflamed gall bladder. Only 5 patients had typical colics with their present illness and only 5 others required opiates for relief. The remainder had characteristic gall-bladder pain of moderate or severe grade. The majority of patients localized their distress to the right upper quadrant (Table V). One had pain only in the left upper quadrant and in 2 patients diagnosis was made and the patients operated upon for acute appendicitis because of right lower quadrant localization.

Indigestion. Five patients denied any history of previous gastro-intestinal distress; 3 gave a history of indigestion only with the present illness and denied any previous trouble. The majority, however, had had typical gall-bladder indigestion of many years' standing. Vomiting was absent in 11 of the 43 patients.

Tenderness. The physical signs were of much greater aid in diagnosing the acute lesion in most of these patients, although in many the signs were so indefinite and vague that the diagnosis of acute trouble was overlooked (Table IV). Three patients had no localized abdominal tenderness, and 5 had only mild grades of local or diffuse tenderness. In the former group, 1 patient had a perforation of the gall bladder; 1 had an acute exacerbation of chronic empyema with free pus in the peritoneal cavity; and the third had a recent acutely inflamed empyema. The majority of the patients, however, had definite right upper quadrant tenderness with positive Murphy maneuvers. In the latter group, 1 patient had a large femoral hernia which was considered incarcerated. The hernia was not strangulated and the acute abdominal condition was found due to bile peritonitis, secondary to a ruptured gall bladder.

Jaundice. Jaundice, as determined clinically, was absent in 30 of the 43 patients. This was quite surprising, inasmuch as we have been led to believe it frequently accompanies acute cholecystitis.

TABLE V.—LOCALIZATION OF PAIN

Localization	Cases	Mass
Diffuse	5	Present 12
R. U. Q.	10	Absent 13
L. U. Q.	1	
R. L. Q.	2	
Shoulder	1	
Back	1	

TABLE VI.—FEVER AND WHITE COUNT

Temperature	Cases	W. B. C.	Cases	Differential	Cases
98.6	6	8500–10000	5	6–65	1
99	7	10000–11000	1	65–70	0
99–100	15	11000–12000	3	70–75	2
100–101	3	12000–13000	2	75–80	8
101–102	3	13000–14000	0	80–85	12
102–103	4	14000–15000	2	85–90	11
103–104	5	15000–16000	1	90–95	8
		16000–17000	7		
		17000–18000	4		
		18000–20000	7		
		20000–25000	6		
		25000–30000	3		
		30000–40000	1		

Rigidity. Local rigidity was totally absent in 2 of the patients and only suggestive rigidity was noted in 6. In the former, 1 patient had a gangrenous gall bladder without stones secondary to carcinoma of the gall bladder, and the other had a perforation with a deep-seated local abscess at the neck of the gall bladder. Most of the patients, however, had very frank local or general rigidity. A mass was palpable in 12 of the patients and noted as absent in 13.

Fever. The fever chart probably offered the most surprising data (Table VI). Six of the patients had normal temperatures during the hospitalization period before surgery. One of these had normal temperatures every 4 hours for 5 days, yet at operation free bile was found in the peritoneal cavity from a perforation of the gall bladder. One patient's fever chart for 3 weeks was normal, yet at operation a perforated gall bladder with an abscess containing 5 stones was found between the liver and the gall bladder. One patient had but a single temperature recording, that was 97, and a ruptured gall bladder and general peritonitis were found. One patient had a temperature of 98 to 98.6 degrees for 12 days, yet at operation perforation of the gall bladder with free bile in the peritoneal cavity was found. Another patient had a temperature of 99.6 degrees on the day of entrance into the hospital; the next day it was normal and remained so for 10 days, yet at operation she had a perforated gall bladder with a large local abscess containing a stone between the neck of the gall bladder and the duodenum. The sixth patient had a temperature of 98.8 degrees, yet at operation 10 hours later he had a gangrenous gall bladder with a perforation and free bile in the abdominal cavity. Several of the patients with ruptured gall bladders had fevers less than 100 degrees. The patients with acute empyema of the bladder, as a rule, had the highest and most constant fevers. The fever graphs, however, were less elevated than might be expected, especially in the cases in which perforation or localized gangrene were present.

White count. The polymorphonuclear white cells gave the best laboratory indication of acute inflammatory disease (Table VI). A majority of these patients had a white count of over 16,000. Only 5 were below 10,000. These included three perforations, a gangrene, and an acute empyema. The differential count was also high, although not as definitely indicative as the total white count. One patient who had a perforated gall bladder with a walled-off abscess had a polymorphonuclear count of only 62 per cent; 1 with an acute empyema had a 73 per cent differential; while another ruptured gall bladder had 74 per cent as the highest count during his 12 day period of observation in the hospital. Some of these low counts, however, may not represent the true picture, for only two or three counts were taken during a week's observation; patients operated upon a few hours after entrance into the hospital had only a single count recorded.

TABLE VII.—OPERATIVE MORTALITY STATISTICS

Acute pathology	With stones	Without stones	
Perforation	11	6	
Gangrene	6	6	
Acute empyema	11	2	
Cholecystectomy	**Cases**	**Mortality**	
Perforation	4	0	
Gangrene	9	2	
Acute empyema	9	0	
Cholecystostomy			
Perforation	13	6	
Gangrene	3	1	
Acute empyema	4	2	
Operation—number of days after onset of present illness			**Per cent**
1 to 4 days			
Perforation	5	3	60.0
Gangrene	7	2	28.5
Acute empyema	6	2	33.0
4 to 7 days			
Perforation	2	2	100.00
Gangrene	0	0	
Acute empyema	1	0	
7 to 21 days			
Perforation	10	1	10.0
Gangrene	5	1	20.0
Acute empyema	6	0	
Operation—hours after entrance to hospital			
1 to 24 hours			
Perforation	7	5	72.0
Gangrene	9	2	22.0
Acute empyema	5	1	20.0
24 hours or more			
Perforation	10	0	
Gangrene	3	1	33.0
Acute empyema	8	1	12.0

The classical clinical picture of acute cholecystitis is represented by the patient who has a history of severe epigastric or right upper quadrant pain of 3 or 4 days' duration, radiating posteriorly and to the right shoulder, with vomiting, local gall-bladder tenderness, and abdominal rigidity, high fever and markedly increased leucocytosis, with possible jaundice. Only 2 of the 43 patients had all of these classical signs. Eleven of the 43 presented all the signs except jaundice (25 per cent). Six patients had all these signs except jaundice, vomiting, and fever, and 2 also lacked increased white counts. One patient had all but fever and an increased white count, but 4 patients lacked vomiting as well as fever and abnormal leucocyte counts. The first of these patients had a ruptured gall bladder with bile peritonitis. Three of the latter were perforations and 1 had gangrene of the gall bladder. Of the 17 remaining patients all had increased white counts but were lacking in either fever, vomiting, rigidity, or severe pain. The majority of the patients therefore lacked one or more of the cardinal signs of an acute inflammatory biliary lesion.

Table VII showing the period of observation in the hospital before surgery was undertaken demonstrates the conservative tendency of the operating staff. Twenty-one patients were observed for more than 5 days before operation was performed. However, it must be remembered that in some of these patients even the diagnosis was not established, much less the stage of the acute pathology. Fifteen patients were operated upon within 6 hours after entrance into the hospital. These patients had most of the classical signs of an acute abdomen, although 3 were operated upon for other acute abdominal lesions and gall-bladder pathology was not suspected. Sixty per cent of the patients having perforated gall bladders operated upon within 4 days after the onset of their acute cholecystic disease died; 100 per cent of those (only 2 in number) operated upon from 4 to 7 days and 10 per cent of those operated upon later than 1 week died. Thirty-three per cent of the patients with acute empyema operated upon within 4 days died, whereas no mortality occurred in those operated upon more than 1 week after the onset of their present illness. These statistics would seem to indicate that delayed surgery in acute cholecystitis offers the better prognosis. It is from such data that the popular conservative attitude has arisen. Unfortunately, these statistics fail to show that pathology and not the time interval is the vital problem. When our tables are analyzed from this point of view we find that patients with acute perforations and gangrene causing general peritonitis must be operated upon very early. The acute perforations on the liver side of the gall bladder and those that are immediately walled off by omentum may be operated upon later, but in the present state of our knowledge we apparently cannot diagnose a perforation from a gangrene or an acute empyema, much less could we anticipate the site of a perforation or its likelihood of being walled-off.

In the patients who had perforated gall bladders and were operated upon a week or more after the onset of their acute symptoms, the relatively low mortality of 10 per cent occurred in those who had walled-off perfora-

tions. Obviously the perforation was slow enough to permit adhesions to wall off the perforating site. Operation might have been instituted at any stage in the walling-off process with equal security. Do we wait for acute appendicitis to wall off? Is the mortality better in perforated or non-perforated appendicitis? The answer, of course, is that early surgery in non-perforated and late intervention in perforated appendicitis is best. And so, indeed, our statistics prove true for acute cholecystitis. Our difficulty lies not in the type of pathology we find after the gall bladder has been operated upon, but rather in what stage shall we operate. And our present study has shown that we are unable to determine before operation what state of pathology, or often even what kind of pathology is present. So we wait, hoping for localization. If it does not occur, mortality is extremely high. If it has occurred, operative mortality is low. But the risk of waiting is greater than the risk of early intervention.

Cholecystectomy was performed in 21 cases with 2 deaths, a mortality of approximately 10 per cent. Cholecystostomy was done in 20 instances with 9 deaths, a mortality of 45 per cent. All the patients had advanced, acute, gall-bladder pathology. There were 19 perforated gall bladders, 11 acute local or diffuse gangrenes, and 12 acute empyemas of the gall bladder. An analysis of the operative deaths shows that 3 of the 11 patients with gangrene (mortality 27 per cent), 6 of the 18 with perforations (mortality 33 per cent), and 2 of the 12 with acute empyema (mortality 17 per cent) died. Acute abdominal lesions were recognized clinically but not in terms of pathology in 3 patients with gangrene, in 6 with perforations, and in 1 with acute empyema who died.

From this study it is evident that our ability to determine clinically the type or stage of acute cholecystic pathology is not well developed. We are justified in watchful waiting, hoping for localization of the acute inflammatory process only under the most favorable circumstances, with hospitalization, adequate nursing, interne, and laboratory facilities. When an acute abdomen of suspected gall-bladder origin is present, exploration should not be delayed too long. The operative risk is less than that of watchful waiting, for the mortality from late complications is greater than the mortality of early surgery. Surgical opinion is swinging toward earlier exploration in acute cholecystitis and statistical studies seem to warrant this course. Improvements in pre-operative and postoperative care and better types of anæsthesia are undoubtedly the reasons for this recent lowered mortality.

My present study, though it covers a relatively small series of cases, indicates that a change from the earlier policy of delayed investigation is warranted. I have previously felt that our attitude should be conservative in acute cholecystitis except in cases of gangrene. But from recent experiences and those of others recorded herein it is evident that we are unable to detect clinically acute gangrene, perforation, or even empyema of the gall bladder with sufficient accuracy. Patients who we believe have an acute empyema later prove to be suffering from gangrene or perforation. We pursue the policy of watchful waiting with the hope that the acute inflammatory reaction will subside or localize. When finally forced to operate we find to our chagrin that peritonitis is already present. The recent statistics of surgeons who have explored these cases earlier are indeed better than our own. Since I have become bolder my mortality has also decreased. None of the few (9 only) cases of acute empyema in which I have performed early cholecystectomy have died. This is in accord with the experiences of Fowler, Graham, Santee, Estes, and Hayes. I believe that the future studies of others will uphold the contention of these writers in advocating earlier surgical consultation and laparotomy in cases of suspected acute cholecystitis.

SUMMARY

1. The pathology present in acute cholecystitis cannot be adequately evaluated clinically.

2. Exploratory laparotomy should be instituted earlier in suspected cases of advanced acute cholecystitis.

3. Perforations and gangrene of the gall bladder occur more frequently than is usually believed.

4. Acute empyema of the gall bladder is best treated by conservative surgery (i.e., cholecystostomy).

5. Perforations and gangrene warrant early cholecystectomy.

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POSTOPERATIVE PULMONARY COMPLICATIONS

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Pulmonary complications have always existed as a very real problem in the postoperative management of the surgical patient. The early literature on the subject of anæsthesia in relation to surgery has in it little or no comment regarding the incidence of pulmonary complications, probably because of the short anæsthesia and the speed in which the surgical procedures of the day were performed, together with failure to diagnose the condition as existing.

Pulmonary disease has been found to occur in from 1.5 to 3.5 per cent of all postoperative cases with a resultant general mortality of from 0.3 per cent to 0.7 per cent which can be definitely ascribed to the pulmonary complication. When one realizes that approximately one in every two hundred patients submitted to surgery will succumb directly as a result of a pulmonary complication, the great importance of this subject becomes apparent. On this basis we have undertaken a critical analysis of all the postoperative pulmonary complications occurring on Service C of the Hospital of the University of Pennsylvania during the past 9 years, in the hope of obtaining information which will enable us more successfully to combat them. These statistics have been taken from this one service of this one hospital rather than from more than one in order that constant factors of housing, clothing, heating, surgical care, technique, etc. would obtain.

The inherent fallacy of a statistical study is well known and appreciated. To minimize this error an accurate definition of what is considered a postoperative pulmonary complication becomes necessary. On Service C any patient who manifests any abnormal postoperative temperature reaction, or who continues to run an unusual elevated temperature for a period longer than the 3 or 4 days associated with the postoperative reaction, is studied carefully by all available means to ascertain the presence of pulmonary pathology. All patients who demonstrated evidence of a pulmonary lesion, either to physical examination or to roentgenological study, are included in the group if such findings are elicited between time of operation and discharge from surgical service.

From September, 1922, to September, 1931, there were 7,326 operations performed on Surgical Service C, and these form the basis of this study. These operations were all general surgical procedures and do not include gynecological, urological, neurosurgical, or otolaryngological surgery. In this series 120 proved postoperative pulmonary complications occurred, and in 39 of them death occurred. This represents a morbidity of 1.68 per cent and a general mortality from pulmonary complications of 0.54 per cent. It will be interesting to note that the general mortality as well as the incidence of pulmonary mortality and morbidity has undergone a gradual reduction during the last 5 years (Table I).

During this same period of observation, 22,962 operations were performed on the entire surgical service of the University of Pennsylvania Hospital exclusive of the departments of gynecology, orthopedics, and otolaryngology. In this entire series the morbidity from postoperative pulmonary complications was 1.38 per cent.

TABLE I.—MORTALITY STATISTICS, SERVICE C, 1922–1931

Year	Operations	Operative deaths, all causes	Operative deaths, all causes %	Pulmonary complications	Fatalities, pulmonary complications	Morbidity %	Mortality from pulmonary complications %	Mortality of morbidity %
1922–23	626	31	4.95	17	7	2.71	1.11	41
1923–24	891	31	3.5	9	5	1.01	0.56	55
1924–25	871	36	4.1	20	4	2.29	0.45	20
1925–26	932	34	3.65	18	3	2.13	0.32	16
1926–27	784	32	4.08	7	3	0.89	0.38	42
1927–28	806	19	2.35	24	6	2.97	0.74	25
1928–29	782	24	3.06	10	4	1.27	0.51	40
1929–30	792	28	3.53	10	4	1.27	0.50	40
1930–31	842	16	1.19	5	3	0.59	0.35	60
	7326	251	3.37	120	39	1.68	0.54	32.5

Pulmonary complications occurring during the postoperative period have a high mortality rate in practically all series. In these 7,326 cases in which operation was done, there was a total operative mortality of 251 cases, or 3.42 per cent. Of the 120 cases of postoperative pulmonary complications, 39 patients, or 32.5 per cent, died. Postmortem examinations were made in 15 of the 39 fatal cases. It is thus apparent that 15.5 per cent of the total operative mortality could be attributed either partially or entirely to the postoperative pulmonary complication, and in 21 fatal cases, or 8.35 per cent, the death was entirely attributed to the pulmonary lesion. It is chiefly in the reduction of this latter group that the prophylaxis of pulmonary complications has its great place.

The incidence of postoperative pulmonary complication has been found to vary by the different authors reporting series in the literature. It is interesting to note that those men who have reported their series annually report an increasing morbidity with a corresponding fall in mortality. This is probably the result of a very diligent search of the available material for the occurrence of pulmonary complications and the more frequent recognition of small areas of lobular atelectasis during the early postoperative period.

For many years the factors concerned in the causation of pulmonary complications have been the subject of discussion among surgeons. Two schools eventually developed in the controversy. The first, lead by Cutler, attributed the pulmonary lesion to emboli and infarction due to trauma at the operative site, while the second school considered aspiration of infected material to be the mode of production. The essential facts in favor of the aspiration theory are as follows: (1) Experimentally and clinically, material from the mouth may gain access to the trachea and lungs during anæsthesia. (2) In animals under ether, colored matter in the stomach may reach the lungs if the animal is allowed to vomit. (3) The pneumococcus type IV is responsible for the majority of postoperative pulmonary complications and it is well known to be a common organism in oral secretions. (4) Pre-existing lung lesions frequently flare up with anæsthesia. The chief arguments advanced by Cutler in favor of the embolic theory are: (1) Complications occur frequently in the hands of skilled anæsthetists. (2) They occur after local and spinal anæsthesia. (3) Fact that such a small proportion of those patients taking ether get a postoperative lung lesion. (4) Oral hygiene seems to play but a small part in the occurrence of these lesions. (5) Lymphatic and vascular channels leading to the lungs offer an ideal anatomical route for emboli to travel. (6) Abrupt onset suggests an embolic onset. (7) Emboli are occasionally found plugging branches of the pulmonary arteries in fatal cases.

Obviously there were many difficulties encountered in attempting to explain these complications entirely by either theory.

In 1890, William Pasteur first described a condition which he called massive collapse of the

TABLE II.—PULMONARY COMPLICATIONS ON SERVICE C AND ENTIRE SURGICAL SERVICE

	Entire surgical service	Service C
Total cases 1922–1931	22,962	7,326
Total pulmonary complications	317	120
Total number fatalities from pulmonary complications	....	39
Morbidity—pulmonary complications	1.38%	1.68%
Mortality—pulmonary complications	....	0.54%
Mortality of morbidity	....	32.5%

TABLE III.—INCIDENCE OF PULMONARY COMPLICATIONS AS REPORTED BY VARIOUS AUTHORS

Author	Year	Operations	Number pulmonary complications	Morbidity %	Number fatal cases	Mortality %	Mortality of morbidity %
Schultze	1899	5,924	22	.38			
Armstrong	1906	2,500	55	2.2	32	1.28	58
Homans	1909	1,409		.56			
Whipple	1913	1,902	42	.22			
Whipple	1915	3,719	97	.26			
Cutler	1916	3,490	65	1.86			
Joslin and Gage	1918	1,423		2.1			
Whipple	1918	3,719	97	2.6	25	.67	25.7
McKesson (Combined statistics)	1918	39,438		3.03		1.06	
Cutler	1919	1,562	55	3.52	11	.7	20
Cutler	1920	1,604	63	3.92	5		7.9
Decker	1920	5,976	69	1.2	29	.5	42
Cutler	1921			3.08			
Decker	1921	2,125	16	.7	6	.3	37
Elwyn	1922	2,932	81	2.76	20		25
Cook and Pickles	1923	1,000	39	3.9	9	.9	23
Elwyn	1924	1,833	63	3.4	9		14.2
Foss and Kupp	1930	3,433	60	1.7	25	.7	41
Eliason and McLaughlin	1932	7,326	120	1.68	39	.5	32.5

lung. This was much further studied by Sir J. Rose-Bradford during the late war and was especially brought to the attention of American surgeons by Scrimger, in 1921. Since then the subject of massive collapse in the lobar and lobular forms has been extensively investigated and the literature contains many articles on the subject. Numerous explanations have been offered to explain this lesion. Pasteur and Rose-Bradford consider it the result of a reflex mechanism affecting the intercostal muscles with a subsequent absorption of air. Henderson considers it due to hypoventilation plus bronchial obstruction. Coryllos, Mathes and Holman, Lund and Retvo, Brown, Hirschboech, and Elliot and Dingly consider the primary cause to be bronchial obstruction resultant from inspissated secretion. Recently Muller, Overholt, and Pendergrass have offered convincing evidence that a high diaphragm with a loss of its normal pumping action is the primary cause of the collapse while the bronchial obstruction is considered secondary. They found that following upper abdominal operations thoracic expansion was reduced 79 per cent and diaphragmatic excursion was decreased 66 per cent with a resultant loss of 75 per cent in lung capacity. They further showed that 76 per cent of a series of patients examined by X-ray the first day following upper abdominal operations showed an elevated diaphragm with increased trunk shadows interpreted as being the first step in the development of a lobular collapse. These studies essentially substantiate those of Churchill and McNeill, who found that following upper abdominal operations the vital capacity was reduced 50 to 88 per cent of the normal, with an incidence of pneumonia approaching 5 per cent. In lower abdominal operations the vital capacity was reduced 20 to 70 per cent, with an incidence of pneumonia of 0.75 per cent. Following operations on the head, vital capacity was but little interfered with and pneumonia occurred in 0.3 per cent or less of the cases.

These and other studies have led to a somewhat different conception of the origin of postoperative pulmonary complications. Clinical and experimental evidence indicates that areas of lobular collapse with or without symptoms and signs occur in a large proportion of postoperative cases, especially following laparotomy in the upper abdomen. If the affected area be sufficiently large symptoms are usually apparent. If the area be small and not infected, it tends to recover spontaneously. If, however, these atelectatic

TABLE IV.—CLASSIFICATION OF PULMONARY COMPLICATIONS AS TO TYPE OF LESION

Year	1922–23	1923–24	1924–25	1925–26	1926–27	1927–28	1928–29	1929–30	1930–31
Operations performed	626	891	871	932	784	806	782	793	842
Pulmonary complications	17	9	20	18	7	24	10	10	5
Deaths from pulmonary complications	7	5	4	3	3	6	4	4	3
Mortality of morbidity	41%	55%	20%	16%	42%	25%	40%	40%	60%
Lobar pneumonia	0	4	4	3	2	3	0	2	0
Bronchopneumonia	7	2	10	9	2	4	4	3	1
Massive collapse	0	0	3	0	0	8	5	5	2
Bronchitis	5	2	3	3	0	1	0	1	1
Pleurisy	1	0	1	1	1	5	1	0	0
Pulmonary embolism and infarct	3	0	0	1	2	1	0	1	1
Lung abscess	0	1	0	0	0	0	1	0	0
Hypostatic pneumonia	1	0	0	0	0	0	0	0	0
Tuberculosis	0	1	0	0	0	0	0	0	0
Pneumothorax	0	1	0	0	0	0	0	0	0
Empyema	0	0	0	1	0	1	0	0	0

areas become infected from an existing bronchitis, aspirated oral secretion, or by septic emboli, the picture becomes that of a postoperative bronchopneumonia or lobar pneumonia, depending upon the size of the involved area and the virulence of the infecting organisms. Such a conception of postoperative pulmonary pathology is outlined by Coryllos, Henderson, and Elwyn, who essentially identified postoperative bronchitis, atelectasis, bronchopneumonia, and possibly abscess as different stages of the same process (Table IV).

The presence of infection at the time of operation, either in the operative site or in the respiratory passages, materially increases the possibility of postoperative pulmonary complications. In our series of 120 cases, 19 had colds or chest signs at the time of operation. All but 5 of these were acute surgical emergencies or septic cases and immediate surgery was required. Of these 19 patients with respiratory infection, 6 succumbed directly as a result of their respiratory complication and 4 others died, the pulmonary complication being a contributing factor in causing death. Joslin and Gage report that 10 per cent of their series of pulmonary complications gave a history of having had a recent respiratory infection. Whipple reports that 21 of his series of 97 cases had colds at the time of operation. Elwyn found a history of a recent cold or bronchitis in 25 per cent of his series of 89 cases and similar findings were noted in 13 of 69 cases of pulmonary complications reported by Cutler and Hunt. Whipple found that type IV pneumococcus was present in the sputum both before and after operation in a group of cases that developed postoperative pulmonary complications, and he considers that this is the usual organism responsible for the infection in the lung.

In our series, 55 of the 120 cases came to operation as acute surgical emergencies and 41 of the cases are listed as septic, pus being present at the operative site.

Bronchopneumonia was the most common complication, being observed in 45 cases. Atelectasis was noted 23 times, lobar pneumonia 18 times, and embolism and infarction 9 times. The lower lobes were the ones most commonly affected and the right lower lobe appeared to suffer more frequently than the left. In our series the right chest was the one affected in 39 cases, the left in 19, and in the remaining 69 cases the lesion was either bilateral or the side affected was not stated.

The rôle of anæsthesia in the etiology of postoperative pulmonary complications has been an interesting one. When the administration of inhalation anæsthesia had become a standard procedure pulmonary complications were promptly attributed to the anæsthetic and the term "ether pneumonia" became a familiar one. Pasteur was one of the first to attack this idea in an attempt to free the anæsthetist from the stigma of the postoperative pulmonary complication. In recent years with the use of a wide variety of anæsthetics, it is apparent that pulmonary complications do occur regardless of the type of anæsthetic agent and the mode of administration. A study of the

TABLE V.—INCIDENCE OF PULMONARY COMPLICATIONS WITH VARIOUS TYPES OF ANÆSTHESIA

	Broncho-pneumonia	Lobar pneumonia	Hypostatic pneumonia	Massive collapse	Acute bronchitis	Pleurisy	Lung abscess	Empyema	Tuberculosis	Pulmonary emboli or infarcts	Total complication according to anæsthetic
Drop ether	9	2	1	6	7				1	3	29
Intratracheal ether	1	1		1							3
Ether (through machine)	1	1		1							3
Nitrous oxide gas—ether	18	4		4	4	2	1	1		2	36
Nitrous oxide gas	2	2		1	2	2				1	10
Nitrous oxide gas—local	3	2		2						1	8
Local	6	3		2	3	1		1			16
Spinal ether				1							1
Spinal	2			3	1					1	7
Splanchnic	1	1		1							3
Splanchnic and nitrous oxide gas		1									1
Ethylene				1		1				1	3
Ethylene ether	2										2
No anæsthetic	1	1									2
Total—type of complication	46	18	1	23	17	6	1	2	1	9	

anæsthetic charts of each of our 120 cases shows that in only 12 instances the anæsthetist noted that the patient took the anæsthetic poorly or that the anæsthetic was a particularly difficult one. The 98 remaining cases are listed as smooth and uneventful. Nitrous oxide gas-ether was the anæsthetic combination most frequently followed by pulmonary lesions in this series, with open drop ether second, and local anæsthesia third.

Lowen in the Leipzig Clinic found pulmonary complications more frequent following local anæsthesia in abdominal operations and Mikulicz found the percentage of pulmonary complications relatively greater following local anæsthesia. Elwyn reports the morbidity of postoperative pulmonary complications as 4.5 per cent in a series of hernias done under general anæsthesia and 8.1 per cent in a series done under local anæsthesia. Cutler found the incidence of pulmonary complications following laparotomy to be the same with local and general anæsthesia but the incidence was less following operations on the head and neck in a series in which local anæsthesia was employed. Brown contends that the incidence of atelectasis is higher in those cases in which spinal is used instead of regional or inhalation anæsthesia. Foss and Kupp, in a series of 400 consecutive laparotomies done under spinal anæsthesia, report the incidence of pulmonary complications to be 1.7 per cent which is identical with the morbidity in a series which they previously reported in which inhalation anæsthesia was used (Table V).

TABLE VI.—DURATION OF ANÆSTHESIA AND INCIDENCE OF PULMONARY COMPLICATIONS

Duration of anæsthesia	Cases
0 to 15 minutes	5
15 to 30 minutes	12
30 minutes to 1 hour	51
1 hour to 1½ hours	30
1½ to 2 hours	13
2 hours to 3 hours	10

That the length of the anæsthesia has a definite bearing on the number of pulmonary complications, there can be no doubt. In the early days of anæsthesia, surgeons were accustomed to look upon the anæsthetic agent as a poison, and it was deemed advisable to complete the operative procedure with the maximum expediency in order to reduce the anæsthetic period. While the quality of anæsthetic agents and the technique of administration have been greatly improved, examination of Table VI shows that by far the greatest number of complications occur in those operations extending over the 30 minute period. It would, therefore, seem that reduction of the anæsthetic period to the shortest possible time would serve as an important prophylactic measure in preventing pulmonary complications.

TABLE VII.—COMPLICATIONS AFTER OPERATIONS ON VARIOUS PARTS OF BODY*

Operations on	Total pulmonary complications	Mortality (all cases with pulmonary complications)	Pulmonary complications responsible for death	Pulmonary complications contributing factor	Patients with elevated temperature, pulse, and respiration at operation	Septic cases	Cases with colds or pulmonary complications before operation	Clean cases (normal temperature, pulse, and respiration), no infection in operative site	Emergency cases—acute (operated on admission)	Non-emergency cases	Per cent mortality of morbidity (entire)	Per cent mortality of morbidity (absolute)
Appendix	35	6	2	4	24	14	8	19	26	9	17.1	5.7
Small intestine	21	3	2	1	5	5	2	14	6	15	14.3	9.5
Hernia—inguinal and femoral	15	2	2		2	2	2	11	4	11	13.3	13.3
Stomach†	4	2		2	1	1	0	3	1	3	50	0
Biliary tract	18	6	4	2	7	7	3	10	6	12	33.3	22.2
Intestinal obstruction	1	0	0	0	0	0	0	1	0	1	0	0
Lower extremity	10	8	5	3	5	5	1	2	6	4	80	50
Upper extremity	2	2	0	1	0	1	0	1	2	0	100	0
Head	1	1	1	0	1	0	1	0	0	1	100	100
Chest and breast	3	3		1	0	2	0	1	1	2	100	0
Kidney	1	1	1		0	0	0	1	0	1	100	100
Spleen	1	1	1		1	0	0	1	0	1	100	100
Hernia—umbilical and incisional	2	1	1		0	0	2	1	1	1	50	50
Prostate	1	1	1		0	0	0	1	0	1	100	100
Rectum and anus	1	0	0	0	0	0	0	1	0	1	0	0
Pancreas	3	1	0	1	2	2	0	1	2	1	33.3	0
Mediastinum	2	1	1	0	0	1	0	1	0	2	50	50

*Septic cases in this table mean that a definite infectious process was present and all cases of appendicitis required drainage.
†Exclusive of gastro-enterostomies, which are included under small intestines.

It has long been recognized that abdominal surgery is the type most frequently followed by pulmonary complications and those operations near the diaphragm are especially prone to cause chest lesions. In our series appendectomy was followed by the greatest total number of pulmonary complications, with operations on the duodenum and jejunum, stomach, liver and gall bladder, and inguinal and femoral herniorrhaphy closely following. In Table VII may be seen a tabulation of the complications following operations on various regions of the body.

These findings agree essentially with those reported by other men writing on the subject. Joslin and Gage found that 75 per cent of their pulmonary complications followed abdominal operations. Elwyn reports a morbidity of 6.2 per cent in 1,080 laparotomies with an incidence of 10.5 per cent in his gastric cases. Featherstone reports a morbidity of 10.8 per cent in 222 gastric operations as compared with 1.8 per cent in 110 hysterectomies. Sise *et al* found the morbidity of pulmonary complications to be 14.8 per cent following gastric operations and 5.9 per cent following biliary surgery.

That the type of upper abdominal incision employed may have a definite bearing on the postoperative course is suggested by the experience of the senior author during the past years. Recently a midline incision has been employed for all gastric and duodenal surgery instead of the right rectus or paramedian incision previously employed. Since this change was made, not only has the patient been more comfortable after operation and his convalescence been more smooth, but it is the impression that there is less splinting of the upper abdomen and diaphragm with this incision which may serve in part to prevent postoperative hypoventilation and its sequela.

For the purpose of comparing the incidence of pulmonary complications in general surgery with that occurring in other branches of surgery, we

were permitted to review the incidence of such complications seen on the neurosurgical service, the thyroid service, the gynecological service, and the obstetrical service of the University of Pennsylvania Hospital. In 1,401 neurosurgical procedures undertaken during the past 4 years postoperative pulmonary complications have occurred 28 times, a morbidity of 1.99 per cent. Sixteen of these followed operations for pretentorial lesions; 7, operations for subtentorial lesions; and 5, operations on the spinal cord. In a series of 889 thyroidectomies performed during the past 4 years postoperative pulmonary complications were noted 6 times, a morbidity of 0.67 per cent. In 4 of these complications followed operations upon toxic thyroids, and in 2 upon non-toxic thyroids.

In 9,011 operative procedures undertaken in the department of gynecology since 1923, pulmonary complications have been observed 89 times, a morbidity of 0.97 per cent. While bronchopneumonia was the most common pulmonary complication occurring on the thyroid and neurosurgical services, as it is on the general surgical service, pleurisy was the most frequent pulmonary lesion on the gynecological service, with bronchitis second, and bronchopneumonia third. In the last 5,000 cases in the obstetrical department in which operative procedures were carried out, the incidence of pulmonary complications were 1.62 per cent.

It has been stated that postoperative pulmonary complications occur more frequently in those patients who are returned from the operating room with a low blood pressure and this group is also said to develop postoperative phlebitis with greater frequency than those patients who maintain their normal blood pressure. An analysis of our series fails to disclose evidence to support this observation. In our 120 cases, the blood pressure, throughout the operative procedure, was maintained in the majority at or near the pre-operative figure. There was no apparent tendency for patients with low blood pressure readings to develop pulmonary complications. In the 120 cases, only 1 developed an associated phlebitis. Among the 9,011 operations reviewed on the gynecological service, phlebitis occurred 53 times and in 5 cases the phlebitis was associated with a pulmonary complication. Foss and Kupp observed a phlebitis occurring with a pulmonary complication in 3 of their series of 60 cases. In each instance, the pulmonary lesion was the result of an infarct, usually multiple in type.

In the series now being reported, morphine has been used routinely to control the pain of the patient after operation. In addition, the patient is given a preliminary dose, depending upon his size and weight, before going to the operating room, regardless of the type of anæsthesia to be given. Examination of the records of these patients which developed postoperative pulmonary complications fails to show that they received amounts of morphine in excess of that usually given the patient after operation. The comfort that is given the restless patient after operation when his pain is controlled and he is able to rest and breathe without fear of pain, more than outweighs the possible danger of decreasing the patient's respirations to a serious extent. This can be accomplished with amounts of morphine in the average patient that will not render him stuporous and unco-operative. It may be noted that Mathes and Holman, in a recent article, advise against the use of morphine after operation except in minimal doses, suggesting the use of 40 to 80 grains of sodium bromide in tap water by bowel to control pain. The efficacy of bromides to control real pain, however, is still questionable.

Undoubtedly the use of the Gatch bed for the maintenance of a semi Fowler position for the patient who has had an abdominal operation has been a great factor in decreasing the incidence of postoperative pulmonary complications. By placing these patients in a position that decreases as much as possible the tendency to hypostatic congestion and allows more complete expansion of the lungs, the dangers incident to committing a patient to bed for a period of days are lessened. It is well to remember, however, that the semi Fowler position may be to the patient more of a curse than a boon. In the average hospital all Fowler springs are of one or at best two sizes, adult and child. Unfortunately, people individually do not as readily fall into two such groups. Hence we have the picture of the small young adult returned from the operating room and placed in a semi Fowler bed designed for a man of 6 feet or over. The young patient slowly gravitates down in bed until the buttocks rest in the trough at the bottom, but the pressure exerted on his upper calf muscles by the lower break in the bed soon becomes intolerable and he attempts to compensate for this misfit by sliding farther down in bed. In doing this the pressure on his calves is relieved and his knees assume the correct position in relation to the lower bend of the bed. This, however, is accomplished at the expense of his back, the small part of which is now suspended in midair while his buttocks rest on one slope of the bed and his lower chest posteriorly on the other. In this position the patient slumps down, his chest restricted and compressed, his breath shal-

low and short, and his whole attitude one of misery. Disregarding all but the pulmonary element with which we are chiefly concerned, it is obvious that such a patient has been placed in the optimum position to embarrass respiration and promote pulmonary hypoventilation. If these simple things are kept in mind and the bed made to fit the patient by means of pillows and blankets, the patient's convalescence will be not only more pleasant but will tend to be freer from unfortunate pulmonary complications.

Tabulation of our cases according to age shows that 60 per cent of respiratory complications occur in patients between 20 to 50 years, 54 per cent occurring in those patients past 40 years of age. Pulmonary complications in the group of patients below 20 were rare on our service, the majority occurring in those during middle life.

The greater percentage of our complications occurred following operations during the months of November, December, January, February, and March, with a second peak in May. There was then a relative infrequency of occurrence until the following winter months.

These findings are similar to those reported by Featherstone, Rucker, and Cutler *et al.* Joslin and Gage found their series of 485 cases rather evenly divided as to months but their cases were all taken from those observed in the army during 1918 and can scarcely be compared with the larger series reported from civil practice.

Seventy per cent of our series occurred in male patients. While in general, pneumonia is reported to occur more frequently in men than in women, there is apparently a much greater incidence of postoperative pulmonary complications in surgery on male subjects. Exposure to which many men are subjected in their work and the greater incidence of gastric and duodenal lesions in the male may be factors partially responsible for this difference. Rucker and Sise *et al* both report a greater incidence in the male while Featherstone found the ratio of males to females to be 3:1 in his series. These facts can best be explained by the greater embarrassment to the normal abdominal and diaphragmatic respiration in the male following laparotomy while the female with costal respiration is less handicapped by the operative procedure (Chart 1).

As previously stated in this discussion, it is the custom on our service to consider any abnormal temperature rise and all febrile reactions lasting longer than the usual 3 day postoperative period as abnormal and every effort is made to explain these. It is, however, usually during the first 24 postoperative hours that the signs of postoperative hypoventilation and collapse are present, and accordingly these must be looked for especially during this period. Symptoms calling attention to chest pathology appeared quite early in the postoperative course of the affected patients. Twenty-eight of the 120 cases had signs and symptoms referable to the chest during the first 24 hours after operation and 76 during the first 72 hours of the postoperative period. It is this prompt appearance of the complication that caused the earlier clinicians to attribute them entirely to the anæsthesia inhaled (Chart 2).

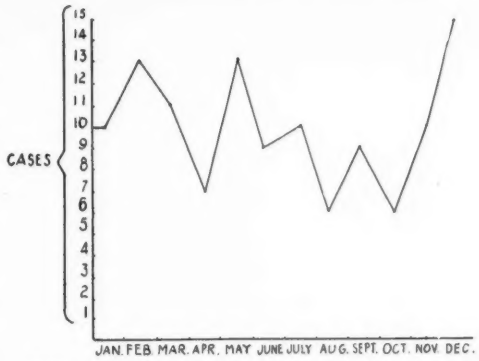

Chart 1. Incidence of pulmonary complications in various months. Series 1922–1931, 120 cases.

In all cases in which it was deemed feasible, X-ray examination was made, and it was a constant practice to have a medical consultant see the cases. In this series, positive X-ray diagnosis was made in 35 cases. In the remaining instances, examination by X-ray was not made either because the patient was too desperately ill to be subjected to such an examination or the lesion was so clear cut and the patient's recovery so prompt and satisfactory that such examination was not considered necessary.

As a class, postoperative pulmonary complications run a very rapid course, ending either with a satisfactory recovery of the patient, or death. During the first 3 postoperative days, pulmonary complications had appeared in 38 of our series and of these 19 succumbed within that period. Eighty-five of the total series were terminated within the first 7 postoperative days, with recovery in 60 and death in 25 cases. In only 35 cases the pulmonary complication lasted longer than 7 days (Chart 3).

Such a summary impresses upon one that pulmonary complications are very malignant as a group, striking early, and most deadly when chest signs appear early with rapid progression.

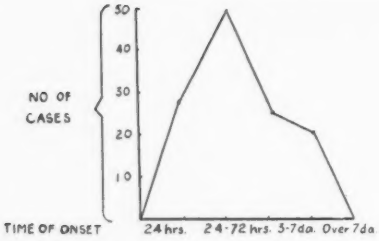

Chart 2. Pulmonary complications as to time of onset in postoperative period.

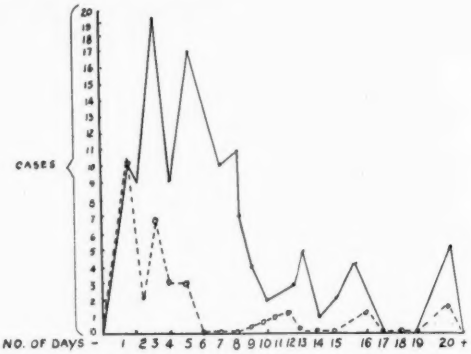

Chart 3. Pulmonary complications according to duration in days shown in solid lines. Dotted lines with open circles represent fatal cases in respect to duration of complication.

PROPHYLAXIS

It will be through a more careful pre-operative, operative, and postoperative supervision that a reduction in the number of these complications will be obtained. Unfortunately, one is handicapped in regulating the pre-operative care of the respiratory tract on a general surgical service where many patients must be operated upon as acute surgical emergencies in spite of the presence of upper respiratory infections. Of these 120 cases here mentioned, 55 were admitted to the hospital as acute emergencies for immediate operation. In this group greater care in the selection of a suitable anæsthetic and more rigid supervision of the chest condition during the postoperative period will no doubt accomplish much.

In those cases in which the patient enters the hospital for an operation of election or for chronic disease, one must accept the responsibility of rendering the respiratory passages as free from foci of infection as possible. Dental and tonsillar sepsis should, in all cases possible, be corrected before more major surgery is undertaken. The presence of a rhinopharyngitis or bronchitis is a definite indication to postpone all but emergency surgery. Every effort should be made to bring the patient to the operating room as free from respiratory infection as possible. All too often impatience on the part of the surgeon, the patient, or his family, causes the operation to be undertaken too soon after an acute respiratory infection. At least 2 weeks should intervene between the last symptoms of the cold and the surgical operation.

It is frequently noted that patients entering the surgical wards for a few days' study before operation develop acute respiratory infections during the pre-operative period. Many factors contribute in the production of these infections, some of which can be controlled by better supervision. The patient on admission to the ward is relieved of the warm clothing to which he has been accustomed and, in their stead, frequently is given an open backed gown and a pair of light trousers. After a hot bath he is assigned to a bed on which he may find sheets instead of heavy blankets between which he has been sleeping. The covering he finds on the bed may be short and somewhat scant and he may be placed beneath one of the windows that is opened each night to insure free ventilation of the ward. If he is a hardy person and does not catch cold, all is well, but some are less fortunate and develop colds which they may take with them to the operating room.

It is because of the frequent occurrence of just this order of events that it is important for the interne or better the assistant to make it an infallible rule to visit each patient on the morning of operation, to ascertain the presence of any abnormality in the temperature, pulse, or respiration, or any recently acquired cold. Because of such findings frequently the operation is cancelled on patients who are found to have a temperature of 99 to 99.2 degrees on the morning of their operation, without other signs or symptoms. Only by such care can dangerous complications be avoided.

In the selection of the best anæsthetic agent for a given patient, many factors are concerned. As previously noted, respiratory infections occur almost as frequently following spinal and local anæsthesia as they do following inhalation anæsthesia. However, considering it purely from the respiratory standpoint, the short sthenic type of individual with a thick, short neck, and a plethoric subcyanotic countenance neither takes nor tolerates well an ether anæsthetic. If in such a patient the surgical procedure to be undertaken can be done as satisfactorily under local or spinal anæsthesia, these would be the agents of choice.

Every patient who presents himself must be individualized and the anæsthetic selected that is safest from every standpoint.

The transportation of the patient to and from the operating room is not without its hazards. Hospital halls, particularly in the older institutions, are notoriously equipped with drafts and every effort should be made to make the trip to and from the operating room as quickly as possible with the patient warmly wrapped. In placing the patient on an operating table, it is well to remember that the only coverings between the patient and the steel of the table are a thin rubber mat and a brief sheet, scant protection for one who will remain fixed in a given position for an hour or longer, probably perspiring profusely during that period.

The value of carbon dioxide as a respiratory stimulant and in the prevention of postoperative hypoventilation and collapse is now well recognized and accepted. Whether the carbon dioxide be given in concentrations of 10 per cent or 30 per cent, and whether it be given in short bursts or over longer periods seem to be but matters of personal preference. The fact remains well established that by its use the frequency of atelectasis is greatly reduced and the subsequent development of infectious pulmonary complications becomes more infrequent.

In this series on our service during the past 3 years, 10 per cent carbon dioxide in oxygen has been given to each patient receiving ether anæsthesia at the end of the operative procedure. It has not been a routine practice in patients receiving nitrous oxide gas anæsthesia or nitrous oxide gas with small quantities of ether vapor, unless the anæsthetic be a difficult one or its administration requested by the operating surgeon. Carbon dioxide in small quantities has not been administered to patients on their return to the surgical wards after operation as is done in some institutions to increase the depth of respiration and hasten the recovery of the patient from the anæsthetic. Pharyngeal suction aspiration is practiced during the anæsthesia when indicated.

On his return to the surgical ward the patient is placed in a flat position until awake if the anæsthetic has been general and then all patients who have had abdominal operations are placed in a semi Fowler position, unless there is some definite contra-indication. Patients receiving spinal anæsthesia are placed in bed with the foot elevated 6 inches, for a period of 6 hours, then flat in bed for 18 hours, and into the semi Fowler position at the end of 24 hours. By following this routine headaches after spinal anæsthesia have been reduced to a minimum, but in those cases in which it is felt important to have the patient in the semi Fowler position earlier, the 18 hour period is reduced and the head is elevated after 9 or 12 hours.

All patients are instructed to take breathing exercises as soon as they are conscious following anæsthesia. These consist in taking at least 10 deep breaths each waking hour. They are told to inspire slowly and gently and then to expire rapidly. The slow inspiration causes less pain and consequent inhibition, while the more forcible expiration not only is not painful but tends to force the mucus up into the position where the cough reflex will dispose of it. The great importance of these exercises is explained to the patient and he is advised to fill his lungs to the greatest possible extent even though with hyperventilation he does experience a little discomfort or pain in the operative site. Often fear of rupturing the incision makes the patient hesitant about taking breaths of the desired depth, and it is explained to him that there are no grounds for his fear. Nurses in charge constantly supervise these exercises and the patient is not permitted to forget their importance.

In all abdominal cases in which it is possible the patients are turned from side to side at intervals of 2 hours. However, they are turned by the nurses on the wards and not permitted to do so themselves until the dangers of resulting complications involved in doing so themselves are past. We feel that this procedure alone is very important in preventing dependent congestion and atelectasis.

Very tight upper abdominal dressings are to be avoided, and unless there is a definite indication, upper abdominal binders are not used. Sise has shown that the use of a tight upper abdominal binder alone can reduce the vital capacity of a normal chest 30 per cent.

Each patient after operation is provided with a shoulder blanket which is carried across the back of the shoulders and neck and over the anterior portions of the chest, covering those portions of the body most exposed to drafts and chilling when one is in a semi Fowler position. Patients continue to wear these blankets while in bed and during the first few days that they are permitted up in a wheel chair.

All these listed procedures are routine in the prevention of the postoperative pulmonary complication. The great importance of rigidly observing this routine in each patient after operation must be constantly emphasized by those supervising the care of patients.

In spite of all effort, pulmonary complications still do and will occur, though we hope the percentage will become smaller. When they do appear they are treated promptly and the advice of an experienced internist is obtained to assist. Symptomatic measures, including a high fluid intake, plenty of fresh air, and rest, are observed routinely. A croup tent with inhalations and small quantities of codeine usually care for the bronchitis frequently seen. Pneumonia when present is treated by the medical consultant. Those cases in which the question of a lobular atelectasis or a pneumonia arises are rolled from side to side at frequent intervals, as described by Sante. An oxygen tent is used, if cyanosis is present. Bronchoscopy may be of value in definite cases of atelectasis as shown by Jackson, Lee, and Tucker. The administration of carbon dioxide has been advised in the treatment of postoperative atelectasis and, on theoretical grounds, it would seem to be the treatment of choice. Atelectasis, if unaccompanied by infection, practically always recovers spontaneously within a short period but the great danger lies in the possibility of these atelectatic areas becoming infected with the development of a pneumonia with its high mortality.

SUMMARY AND CONCLUSIONS

1. An analysis of 7,326 general surgical procedures is presented in which 120 postoperative pulmonary complications occurred with 39 fatalities.

2. The morbidity of postoperative pulmonary complications in this series was 1.68 per cent, with a general mortality of 0.54 per cent from this complication.

3. In this series 32.5 per cent of the patients affected with pulmonary complications died.

4. Postoperative pulmonary complications were entirely responsible for 8.5 per cent of the total operative mortality in this series of 7,326 operations and partially responsible for 15.5 per cent of the total operative mortality.

5. Upper respiratory infections at the time of operation are a very real contributing cause in the development of postoperative pulmonary complications and only acute surgical emergencies should come to operation in the presence of such.

6. Pulmonary complications occur equally following the administration of all anæsthetic agents but the length of the anæsthetic is a definite contributing factor.

7. Operations on the stomach, duodenum, and jejunum are most frequently followed by these complications, with those on the gall bladder and appendix next in order.

8. Blood pressure changes and the use of morphine after operation have had no effect on the incidence of these complications in our series.

9. Pulmonary complications occur with the greatest frequency between the months of November and March.

10. Seventy per cent of our cases were male patients.

11. Pulmonary complications as a class appear early and run a rapidly fatal course to their termination, being fatal in approximately 30 per cent of the affected cases.

12. Carbon dioxide inhalations are of great value in preventing postoperative atelectasis and its sequelæ.

13. All patients after operation should be given supervised breathing exercises and be turned at 2 hour intervals if at all possible.

14. Constricting dressings and upper abdominal binders are to be avoided.

15. Pulmonary complications, when they occur, should be treated promptly with both symptomatic and specific measures for their relief.

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THE SURGICAL MENOPAUSE AFTER HYSTERECTOMY WITH AND WITHOUT OVARIAN CONSERVATION

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IN a recent study of the surgical menopause occurring after hysterectomy with the retention of one or both ovaries, 43 per cent of 91 patients, operated upon before 36 years of age, experienced hot flushes[1] before the age of forty[2]. This percentage was approximately eight times that occurring in a group of women of corresponding ages not operated upon.

The incidence of flushes was found to be lower in the patients who menstruated subsequent to operation than in those who did not menstruate; and also less frequent among women retaining both ovaries than in those from whom one had been removed. From these observations, it was concluded that, when attempting to prevent the development of the surgical menopause, ovarian and endometrial conservation serve the best interest of the patient subjected to a hysterectomy during the childbearing period.

On the other hand, certain observers advocate extirpation of both ovaries when the uterus is to be removed before the climacteric. They claim that, though more severe, the subsequent surgical menopause is shorter; that this short but severe condition is preferable to a less acute one which will be more prolonged.

The authors concluded that conservation is the policy of choice because, following its pursuit, fewer patients developed symptoms of the surgical menopause. This feature was not mentioned by the observers already alluded to, who tacitly assumed that a surgical menopause would develop; they were concerned primarily with its duration.

Since these two points of view in determining the extent of operation were diametrically opposed, largely, if not entirely, because they were based on different observations and reasons, a second study was undertaken.

These observations were made upon patients operated upon in the John G. Clark Clinic of the Hospital of the University of Pennsylvania. Ninety-one women, subjected to a hysterectomy with the conservation of one or both ovaries[3] and 52, subjected to a hysterectomy and a bilateral oophorectomy, were studied. A subtotal hysterectomy was the operation of choice in both groups, on all but 6 patients; a total hysterectomy was performed upon the latter. All were operated upon before the thirty-sixth year of life. They were followed either by mail or were interrogated in the Hospital Follow-Up Clinic; and in many instances information was secured from both sources. The study concerned patients operated upon between the years of 1916 and 1930. Data were collected concerning the incidence, the onset, and the severity of the flushes, and the number of months or years that they were experienced. It is our belief that their presence is the best index that the menopause has set in; and, on account of the definiteness of this symptom, and the vagueness of the other menopausal symptoms, the flush was the only symptom investigated.

Incidence of flushes. Of 91 patients subjected to hysterectomy with conservation of one or both ovaries, 40 (43.9 per cent) developed hot flushes before 40 years of age, whereas, of 52 patients who were subjected to hysterectomy with bilateral oophorectomy, 42 (80.7 per cent) developed hot flushes before 40 (Table I). From these observations, it is evident that the flush was much more common after bilateral than after unilateral oophorectomy.

Onset of flushes. Of 40 patients developing flushes after hysterectomy with ovarian tissue conservation, 14 (35 per cent) developed them during the succeeding 3 months, whereas, of 42 patients experiencing flushes after hysterectomy with removal of both ovaries, 35 (83.3 per cent) developed them during the same period of time (Fig. 1). The flushes appeared sooner, therefore, after bilateral than after unilateral oophorectomy.

Severity of flushes. Of the 40 patients who experienced flushes after hysterectomy with ovarian conservation, 15 (37.5 per cent) described the flushes as being severe, while the remaining ones used the terms moderate or mild (Table II). Of the 41 patients who experienced flushes after

[1] By most writers, the terms flush and flash are used synonymously. It has been suggested that the term flash be restricted to the sensation which includes an associated visual stimulation. Since in this investigation, no inquiry was made regarding visual stimuli, the term flush is used throughout.

[2] Sessums, J. V., and Murphy, D. P. Hysterectomy and the artificial menopause; review of literature and report of 91 cases. Surg., Gynec. & Obst., 1932, lv, 286.

[3] The records of these patients formed the basis of the previous report, but the latter did not include the data presented here, dealing with the severity and duration of the surgical menopause.

TABLE I.—INCIDENCE OF FLUSHES IN PATIENTS UNDER 40 YEARS

	Number of patients	Per cent
Hysterectomy with conservation of one or both ovaries	91	43.9
Hysterectomy with bilateral oophorectomy	52	80.7

Percentages of patients operated upon before 36 years of age and exhibiting hot flushes before 40 years of age, as influenced by the amount of ovarian tissue removed. Note that, in the group where both ovaries were removed, approximately twice as many women experienced hot flushes as did those in the group where one or both ovaries were retained.

TABLE II.—SEVERITY OF FLUSHES

	Number of patients	Flushes severe
Hysterectomy with conservation of one or both ovaries	40	15
Hysterectomy with bilateral oophorectomy	41	30

Severity of flushes following hysterectomy with and without ovarian conservation. Note that just twice as many women, subjected to hysterectomy with bilateral oophorectomy, reported their flushes as severe, as did the patients, subjected to hysterectomy with ovarian tissue conservation.

TABLE III.—PERIOD OF TIME DURING WHICH FLUSHES WERE EXPERIENCED

	Number of patients	Flushes stopped per cent	Average duration in months
Hysterectomy with conservation of one or both ovaries	40	35	16.2
Hysterectomy with bilateral oophorectomy	41	12	7.2

Percentages of patients subjected to hysterectomy with and without ovarian conservation, who reported that their hot flushes had stopped, and the length of time during which they had experienced these symptoms. Note the very small percentages of patients who reported cessation of flushes, and also the fact that the period of time that the flushes existed was smaller after bilateral oophorectomy than when one or both ovaries were conserved.

hysterectomy with bilateral oophorectomy, 30 (73.1 per cent) described the flushes as severe, and the 11 remaining as moderate or mild (Table II). From this comparison it is seen that, in the group subjected to hysterectomy with bilateral oophorectomy, twice as many women described their flushes as severe, as did those in the group subjected to hysterectomy with ovarian tissue conservation.

Duration of surgical menopause. Of 40 patients subjected to hysterectomy with ovarian conservation, only 14 (35 per cent) reported their flushes as having ceased (Table III). The duration of the surgical menopause in this group averaged 16.2 months. Of 41 patients subjected

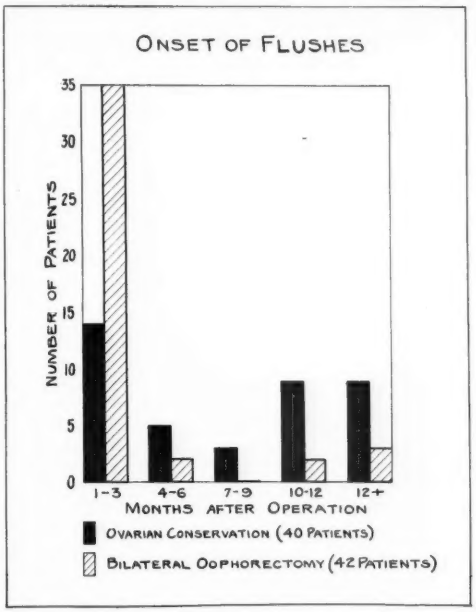

Fig. 1. The interval of time between operation and the onset of flushes developing after hysterectomy with and without ovarian tissue conservation. The base line represents the length of time, in periods of 3 months, between operation and the development of flushes; the vertical line represents the number of patients studied. Note the large number of patients developing flushes within the first 3 months following operation, especially in the group subjected to hysterectomy and bilateral oophorectomy.

to hysterectomy and bilateral oophorectomy, only 5 (12 per cent) reported their flushes as being completed (Table III). The duration in this group averaged 7.2 months. The length of the surgical menopause after bilateral oophorectomy was shorter therefore than after unilateral oophorectomy in the small number of patients where data were available concerning the completed condition. In evaluating this observation, two facts must be borne in mind: first, the small number of patients operated upon in both groups; and, second, the very small percentage of patients (averaging less than 25 per cent) concerning whom information was available. This latter observation is of interest in view of the length of the period of time covered by the study, which was 14 years.

In an investigation of the duration of the surgical menopause of the patients who were experiencing flushes when last observed, it was noted that the lengths of their periods of observations were about equal in the two groups (Fig. 2).

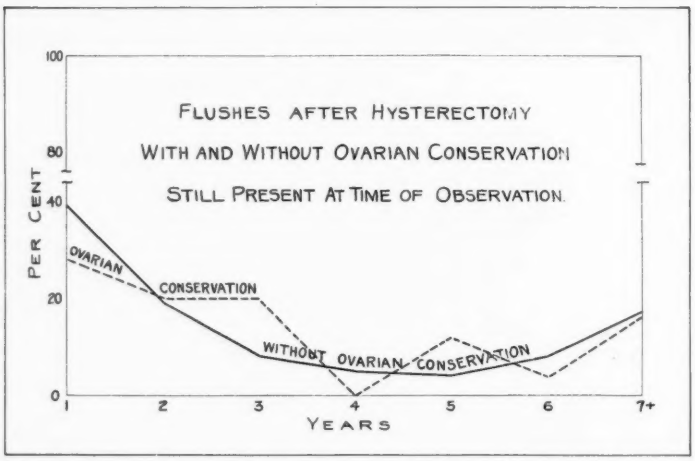

Fig. 2. Polygon curves showing the lengths of the periods of observation of patients who developed flushes after hysterectomy, and who still had them at the time of last observation. The above curve is based upon observations on 25 women on whom ovarian tissue conservation was practiced, and upon 26 women on whom ovarian tissue conservation was not practiced. The base line represents the intervals of time in years between the first flush and the time of last observation. The vertical line represents the percentages of patients in the two operative groups, who were still flushing. Note that, regardless of the length of time between the first flush and the time of the last observation, the percentage of patients in each group was approximately the same.

DEDUCTIONS

In view of the above facts, and especially because of the small number of patients from whom information could be secured concerning the duration of the surgical menopause, it is believed that, as yet, little weight should be placed upon it, in determining the amount of ovarian tissue to be sacrificed, when a hysterectomy is to be performed during the childbearing period.

This report confirms the findings of others, namely, that the incidence of a severe surgical menopause, is much more common when bilateral oophorectomy is performed than when one or both ovaries is conserved. Since the surgical menopause is more likely to occur the more ovarian tissue is removed, since the flushes are more severe under the same conditions, and since the meager information on the duration of the surgical menopause points to the fact that the duration is so slightly different in the two operative groups, it is believed that the advantages of conservative ovarian surgery outweigh those of following a more radical policy. Furthermore, it is believed to be more important to aim at preventing the onset of the surgical menopause than to assume it will occur and then attempt to reduce its length.

SUMMARY AND CONCLUSIONS

1. Ninety-one women, subjected to hysterectomy with retention of one or both ovaries, and 52 women, subjected to hysterectomy and bilateral oophorectomy, both groups before the age of 36 years, have been interrogated with reference to the incidence, onset, duration, and severity of the surgical menopause, as indicated by its most important symptom, the hot flush.

2. The surgical menopause occurred in more patients, it took place sooner, and was more severe after hysterectomy with associated bilateral oophorectomy than when one or both ovaries were conserved.

3. The surgical menopause after hysterectomy with and without associated bilateral oophorectomy, still persisted in three-fourths of our patients at the time of last observation. In the remaining one-fourth, it had been completed. Its duration was shorter after associated bilateral oophorectomy than after hysterectomy with ovarian conservation.

4. From this study, and a previous one, it is concluded that, when hysterectomy is to be performed during the childbearing period, the best interest of the patient is guarded by conservative treatment of ovarian tissue.

STUDIES ON PERIPHERAL VASCULAR PHENOMENA

I. A New Device for the Study of Peripheral Vascular Phenomena in Health and Disease

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MANY plethysmographs have been described since the time of Jan Swammerdam (1637–1680) and he is credited with having devised the first plethysmograph which he used in the study of the physiology of muscular contraction. A diagram of this plethysmograph is shown in his works edited by Boerhaave (1737).[1]

In a previous communication[2] an extremely sensitive, very simple and readily adaptable plethysmograph was described, which, for clinical studies, possesses many advantages over other instruments used for the study of peripheral vascular phenomena. Since that time, many refinements have been added to this device which, it is felt, require further description with indications of its possible applications of the apparatus to physiology and clinical medicine.

THE INSTRUMENT

The plethysmograph previously described (Fig. 1, A) consisted of a 1-inch test tube cut off to about a 3 inch length. A 1 cubic centimeter pipette graduated to 0.01 cubic centimeter was fused to the closed end of a test tube. A glass stop cock was fused to the side of the test tube and the open end of the test tube was covered with dental rubber dam with a hole sufficiently large to admit any finger snugly (Fig. 1, A).

When prepared for use, a drop of colored alcohol[3] is allowed to run to the center of the pipette, the glass stop cock is left open, and the open end of the pipette is covered with the finger. The subject now puts one finger through the rubber dam into the test tube and assumes a comfortable position with the hand and forearm resting on the table. The pipette is kept horizontal and the glass stop cock is closed.

The droplet oscillates with each heart beat. In the normal subject the oscillation varies from 0.01 to about 0.05 cubic centimeter (2 millimeters to 5 or 6 millimeters of linear deflection) depending upon various factors which will be mentioned later. In one case of aortic regurgitation the deflection varied in the third finger of the right hand from 0.04 cubic centimeter to 0.13 cubic centimeter depending upon the degree of vascular dilatation (9 millimeters to 27 millimeters linear deflection).

It is possible to construct these instruments with far greater sensitivity by using pipettes of smaller bores, but for practical use upon patients and dogs they are unsatisfactory. The greater the sensitivity, the greater the difficulty in maintaining adjustments. For ordinary use the instrument described serves very well.

The plethysmographs as now constructed are similar to the first (Fig. 1, A), except that the stop cock is fused to the proximal end of the pipette and the pipette is connected to the test tube by means of a rubber tube. Chambers for other parts such as the toes, leg, and arm can be substituted for the finger chamber and records from these parts made (Fig. 1, B,C,D).

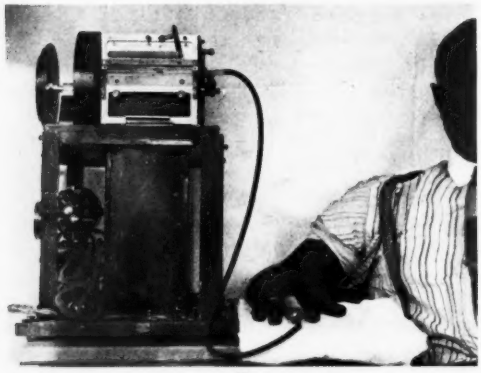
Photographic registration is accomplished by means of a special camera as shown in Figure 1, B,C,D. The pipette is a sufficient distance from the sensitive paper so that the graduation markings appear as horizontal white lines and the finger volume changes are registered by the change of position of the white band (Figs. 2, 3, 4, 5, 6). From the photographic records it is possible to estimate a 0.002 cubic centimeter deflection. Further, with this device, it is possible to obtain graphic records on the five fingers of one hand within

[1] Jan Swammerdam (1637–1680). Biblia Naturae. Edited by Boerhaave (1737). Vol. iii, Table 49, Figures 7 and 8.

[2] Johnson, Carl A. J. Lab. & Clin. Med., 1931, xvii, 59.

[3] A drop of alcohol was used for recording instead of water because of its more desirable physical properties. It has a low specific gravity, low viscosity, and low surface tension, and these decrease its resistance to movement. Furthermore, the drop does not tend to be impeded in its movement by the film of grease which tends to collect on the walls of the pipette.

A



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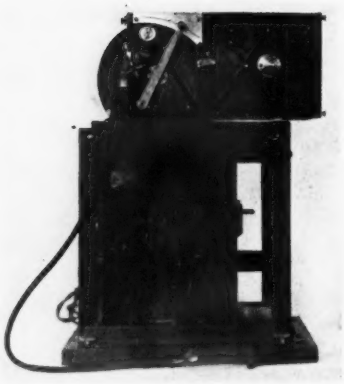

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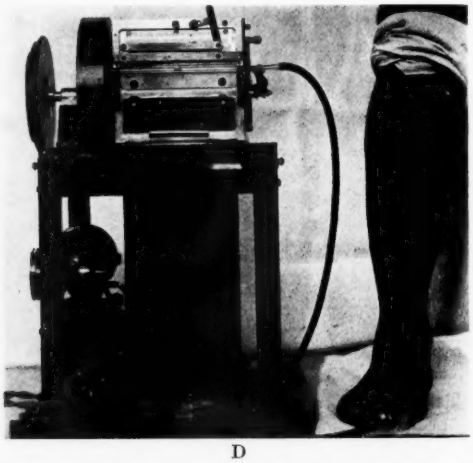

D

Fig. 1. The apparatus (Photograph A) shows the finger plethysmograph as originally designed. Photographs B, C, and D illustrate the device for photographic registration of the movements of the droplet of fluid in calibrated pipette. The droplet is visible in the pipette in B and D.

5 minutes. (Of course this does not include the time required to develop the photographic record.)

ILLUSTRATIONS

The accompanying illustrations demonstrate the utility of the instrument. Further studies upon peripheral vascular phenomena have been made by Drs. Scupham and Johnson as reported elsewhere in this issue.

Figure 2 shows the normal response from the first four fingers of a patient in whom a diagnosis was made of chronic myocarditis

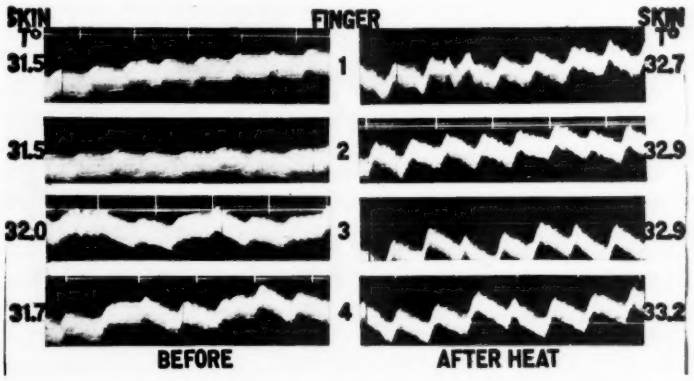

Fig. 2. The normal response in the volume changes of the fingers of the right hand before and after local application of heat. It is noted that local heat induces a marked increase of the pulse volume changes. Occasional extrasystoles are recorded.

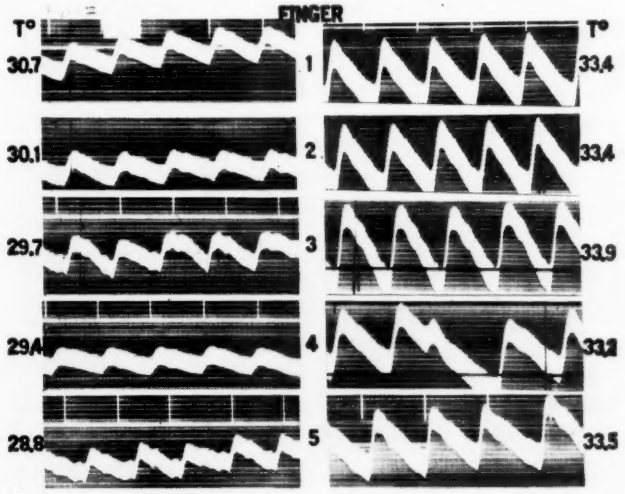

Fig. 3. This record here is similar to that in Figure 2 except that this subject had an aortic regurgitation. The left column is the control and the right column shows the volume changes in the fingers after heat. The blood pressure in the patient was 140/40–0. Note that an extrasystole is recorded in the plethysmogram of the fourth finger.

before and after placing the hand in hot water for 5 minutes. There is an increase of about 400 per cent in the deflection.

Figure 3 shows the striking result from a similar experiment upon a patient with aortic regurgitation. It is noted that the deflection in the control record is above normal, i.e., about four times as great. Placing the hand in hot water also increased the deflection in this case from 300 to 400 per cent. (In finger four an extrasystole is recorded.)

The results of an experiment upon posture and exercise are shown in Figure 4. This is the same case as shown in Figure 3 and the markedly decreased deflection after exercise is possibly explained by the fact that this

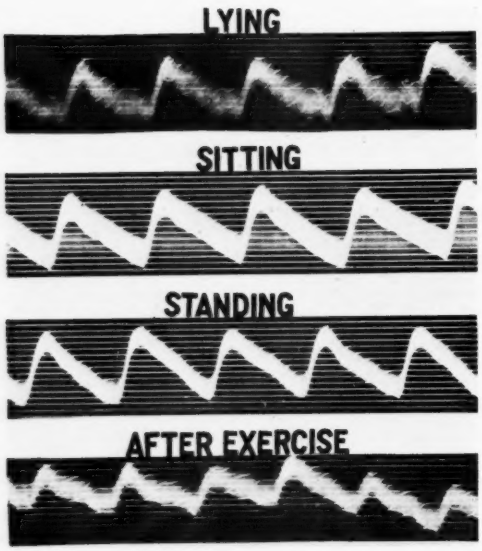

Fig. 4. The effect of posture and exercise on the pulse volume changes of the right index finger in a case of aortic regurgitation with cardiac decompensation. Blood pressure was 140/40–0.

patient is on the verge of cardiac decompensation (the aortic regurgitation is complicated by a bundle branch block).

Figure 5 shows the effect of heat on finger volume changes of one finger of each of four patients before and after the immersion of the hand in hot water. The most striking change occurred in the patient with severe hypertension and arteriosclerosis and serves to illustrate that peripheral vasodilatation is still possible in spite of an obvious arteriosclerosis with marked hypertension. In such a case it is possible to differentiate between functional and pathological constriction of the blood vessels.

Figure 6 is a record of the volume changes in the first four fingers of the right hand of a patient with thrombo-angiitis obliterans before and after immersion in hot water. From the preceding discussion in the normal, one should expect increased deflection following heat which did not occur. (In this case there has been loss of tissue in the first two fingers of the right hand.) The third finger shows a good pulsation. This further illustrates that with this device one can differentiate between functional and organic constriction of the peripheral vessels. (Dr. Scupham and Dr. Johnson are making an extensive study of peripheral vascular diseases and this case represents one of the series.)

Figure 7 shows the changes of volume of the large toe in four subjects before and after immersion in hot water. The character of the impulse is different from that obtained from the fingers in that the return of the deflection to the base line is more rapid for the toes. The cause of this difference is not known. Possibly gravity and the greater distance from the heart are factors. The illustration is self explanatory except that the hypertensive patient had a good response in the fingers but none in the large toe.

DISCUSSION

It was obvious from the start of these experiments that the periodic volume changes or oscillations are associated with the pulse, but occasionally in some subjects there are superimposed slower periodic oscillations which are associated with respiration. It has not been determined whether these later changes are due to periodic vasomotor changes, changes in cardiac output, or artifacts from body movement. Furthermore, in nervous patients the effect of tremor is recorded and these movements must be taken into consideration in the interpretation of results. Figure 2 shows all of these types of changes and was chosen to illustrate that accurate measurements of finger volume changes of cardiac origin can be made in spite of these second and third types of oscillations. This is important since it does not limit the use of the instrument to patients who are not nervous.

The instrument also may be used to measure the more lasting finger volume changes which occur from an increased or decreased vasomotor tone. This was illustrated in a previous communication on "The Effect of Amyl Nitrite upon Finger Volume."[1] It will be recalled from this paper that contrary to the accepted opinion, amyl nitrite may cause a primary decreased finger volume in spite of a potential relaxation of the vessels. This is

[1] Johnson, Carl A. J. Lab. & Clin. Med., 1931, xvii, 59.

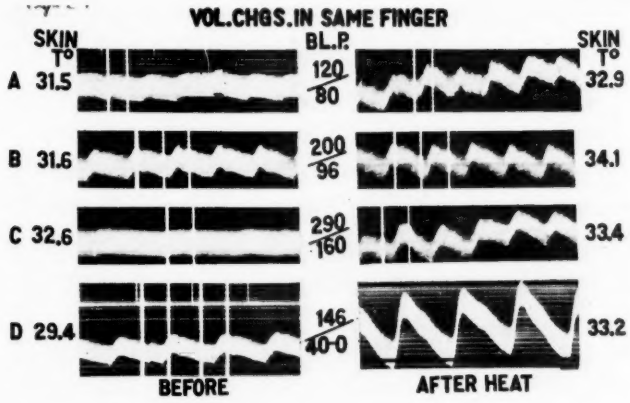

Fig. 5. This figure merely illustrates the various types of plethysmograms one obtains from the finger in patients with various kinds of cardiovascular diseases. *A* Is a "normal" response of a finger to local heat in a patient with chronic myocarditis. *B* Shows a "normal" response to local heat in a patient with an aortic aneurism. The patient has an increased pulse pressure which is reflected in the control record. *C* Illustrates a striking response to local heat in a patient with a marked hypertension on an arteriosclerotic basis. This shows the marked degree of functional constriction of the smaller vessels in this patient as contrasted with the organic constriction in the patient with Buerger's disease illustrated in Figure 6. *D* Shows the increased volume change in the finger of a patient with aortic regurgitation and the marked degree of relaxation of the vessels which may be obtained after application of heat locally.

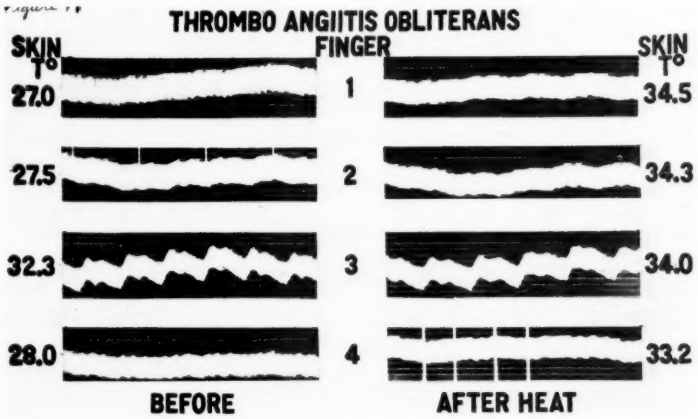

Fig. 6. This figure shows records of the volume changes in the fingers of the right hand of a patient with thrombo-angiitis obliterans. The third finger apparently has a good circulation but the vessels manifest no vasoconstrictor tone, or the entire capacity of the vessels to dilate is being constantly utilized which is evidenced by the absence of an increase in pulse volume change from local heat. This illustrates the utility of the instrument in differentiating between different degrees of organic as well as functional constriction of the smaller blood vessels.

explained by the overwhelming splanchnic dilatation and drainage of the blood from the peripheral blood vessels.

The question of the accuracy of the instrument has arisen. As far as the deflection of cardiac origin is concerned, the plethysmo-

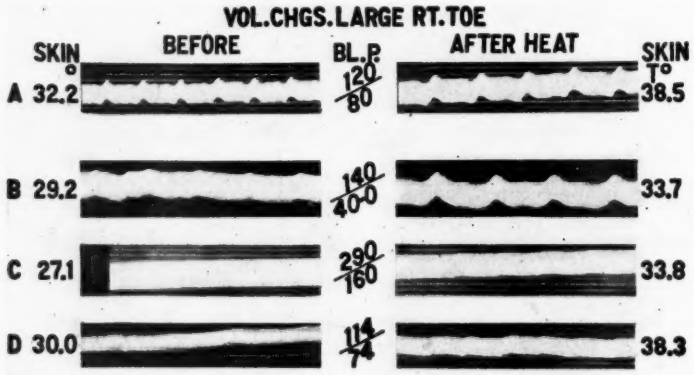

Fig. 7. This figure shows the various types of responses in the large toe. *A* Is the plethysmogram of a normal individual showing that the pulse volume changes in the toe can be demonstrated readily. The response to local heat is not so marked as in the finger. *B* Is from a case of aortic regurgitation. *C* Shows the absence of a pulse wave in the toe from a case of severe arteriosclerosis with hypertension. The reasons for this result are discussed in the text. *D* Is from a case of thrombo-angiitis obliterans which shows a slight response to heat.

graph can be taken off the finger and reapplied numerous times and the same deflection will be obtained. In a finger with a volume of 15 cubic centimeters and a deflection of .015 cubic centimeter, it is calculated that using volumes of 17 cubic centimeters or 13 cubic centimeters of finger will still give values within the range of experimental accuracy, i.e., .002 cubic centimeter. This is important not only from the point of view of accuracy in duplicating results, but also demonstrates the ease of manipulation. In other words, it does not require extraordinary technical skill to obtain consistent results with this instrument.

Another important consideration is the cost of the instrument. The essential portion, i.e., the plethysmograph itself, can be made for two dollars to two dollars and a half which is sufficient for making qualitative observations. It can be carried in the pocket. The camera can be made as elaborately as desired, but the one in use which was found adequate would cost about three hundred dollars to duplicate.

The interpretation of the results is open to some question but it is felt that the same factors which maintain blood pressure in addition to the resistance of the soft tissues of the part in question are the important factors in determining the extent of the excursion which is associated with the pulse. It will be remembered that the important factors which serve to maintain blood pressure are the force and rate of the heart, the volume and viscosity of the blood, the elasticity of the blood vessels, and the peripheral resistance.

For most experiments, all the factors remain fairly constant except the peripheral resistance. Illustrations of changing the peripheral resistance in the finger and toe by immersion in hot water have been shown, and it is felt that this is an index of the degree of vascular dilatation. Furthermore, where there is pathological constriction of the vessels such as in thrombo-angiitis obliterans, such relaxation is not possible. From this and other data it is concluded that with this instrument, it is possible to differentiate between functional and pathological constriction of the blood vessels. In other words, the deflection obtained is dependent upon the ability of the vessels to dilate with each heart beat and in this sense is a measure of vascular dilatation in the part.

There remains little else to be said except that it is felt that this small amount of investigative work with this device illustrates

and points out the utility of the instrument for the study of peripheral vascular phenomena in health and disease.

SUMMARY AND CONCLUSIONS

A new device has been presented for the study of peripheral vascular phenomena in health and disease and illustrations have been shown to demonstrate its utility in physiology and in clinical medicine.

Some tentative conclusions have been drawn:

1. This device may be used to differentiate between functional and organic constriction of the peripheral blood vessels.

2. This device is a more accurate index of vascular dilatation than skin temperatures.

STUDIES ON PERIPHERAL VASCULAR PHENOMENA

II. Observations on Peripheral Circulatory Changes Following Unilateral Cervical Ganglionectomy and Ramisectomy

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From the Departments of Medicine and Physiology, Northwestern University and St. Luke's Hospital, Chicago

SYMPATHECTOMY and sympathetic ganglionectomy have been done for several clinical conditions, with some conflicting results. In this paper we wish to consider only those conditions in which sympathectomy is done in an attempt to increase the blood supply to the whole or part of an extremity.

The literature on the sympathetic nervous system and its relation to the peripheral vascular bed is very extensive, but it may be found in the excellent monographs of Kuntz and Krogh. Unless otherwise indicated, references to the following literature may be found in these monographs. Also the functional activity of the capillaries and venules is reviewed in a monograph by Hooker.

On histological grounds alone it has been demonstrated by numerous authors that fibers from the sympathetic nervous system pass to the arterioles. There is evidence that sympathetic fibers also pass to the capillaries and veins.

Physiologically it has been shown in numerous ways that these fibers are chiefly vasoconstrictor in nature and exert a tonic influence over the peripheral vascular bed. There are also vasodilator fibers but these in most instances are not so readily demonstrable as are the vasoconstrictor fibers. It has also been shown that the capillaries may constrict independently of the arterioles and that this constriction is due in part to vasoconstrictor impulses over the sympathetic.

In addition to this central control over the smaller vessels, there are peripheral mechanisms which aid in regulating the vascular bed purely in a local way. The evidence for this is by direct visual observation of the smaller vessels devoid of any central connections, and this evidence indicates that the vessels not only have an independent contractility but also are influenced by blood changes.

That these mechanisms of peripheral vascular control are effective is shown by the late effects of sympathectomy. According to Kuntz, from experiments upon normal animals, the blood vessels regain their preoperative tone following sympathectomy in 10 days to 2 weeks. It is thought that capillaries regain their tone somewhat more rapidly than the arterioles.

Clinically, sympathectomy has been done for many conditions, but in this report we wish to limit ourselves to sympathectomy for the so called rheumatoid arthritis.

Brown; Rowntree and Adson; and Hench, Henderson, Rowntree and Adson report favorable results following sympathetic ganglionectomy and ramisectomy in rheumatoid arthritis. They indicate that in rheumatoid arthritis the extremities are cold to the touch; and also that there are pallor, areas of cyanosis, puffiness of the tissues, and the extremities are

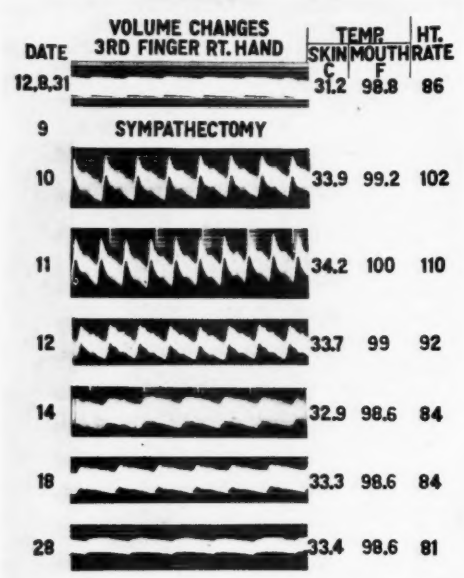

Fig. 1. This figure illustrates the volume changes of the third finger of the right hand before and after removal of the right superior cervical and first and second thoracic sympathetic ganglia. It is to be noted that the pulse volume changes of the finger return to the control level in 21 days.

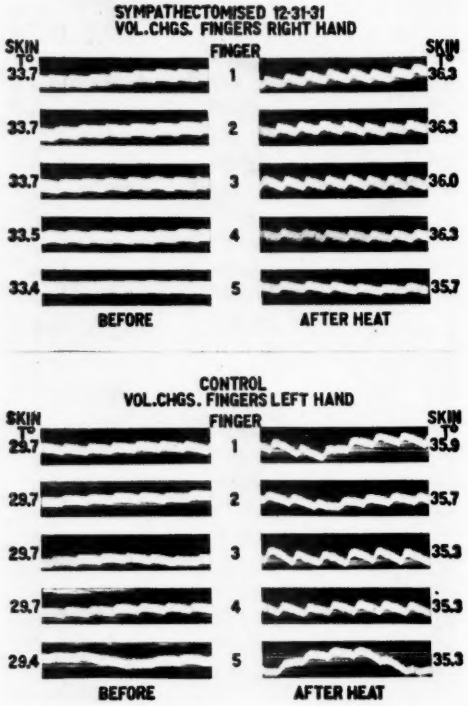

Fig. 2. This figure shows the effect of local heat (45 degrees for 10 minutes) on the pulse volume changes of the fingers of the right hand 22 days after sympathectomy as compared with the effect of local heat upon the volume changes of the fingers of the left or control hand. It is to be noted that a similar response is obtained in the fingers of both hands which shows that in this patient after 22 days, sympathectomy did not modify the reaction of the blood vessels to local heat.

usually moist. They feel that these changes indicate constriction of the arterioles, capillaries, and possibly the venules. On the basis of previous studies on sympathectomy they had concluded from skin temperature studies and calorimetric studies that there is a lasting increased blood flow to the part following sympathetic ganglionectomy and ramisectomy.

With this introduction we wish to offer objective evidence of the results of a unilateral sympathectomy (removal of right stellate and first and second thoracic ganglia) of the upper extremity in one patient with rheumatoid arthritis.

B. C., a white female, aged 22 years, was first admitted to St. Luke's Hospital on August 28, 1929, and has been under constant observation ever since. A diagnosis of rheumatoid arthritis was made at this time.

The early manifestations of her disease started at the age of 12 to 13, but subsided and were not severe until she reached the age of 18. The process has progressed until at the present time all of her joints except those of her spinal column are affected and deformed. She has the characteristic spindle-shaped joints of the fingers.

From time to time various types of medication were instituted in attempts to stop the progress of the disease and to alleviate the pain. Among these were foreign protein therapy, sulphur injections, an extensive course of vaccine therapy, a unilateral cervical ganglionectomy and ramisectomy of the upper extremities, and finally ankylosis of the wrist joints.

Sympathectomy of the right arm (removed right stellate and first and second thoracic ganglia) was done by Drs. Hedblom and Harold I. Meyers on December 9, 1931. Control studies on skin temperature and circulatory changes were made at various intervals before and after operation.

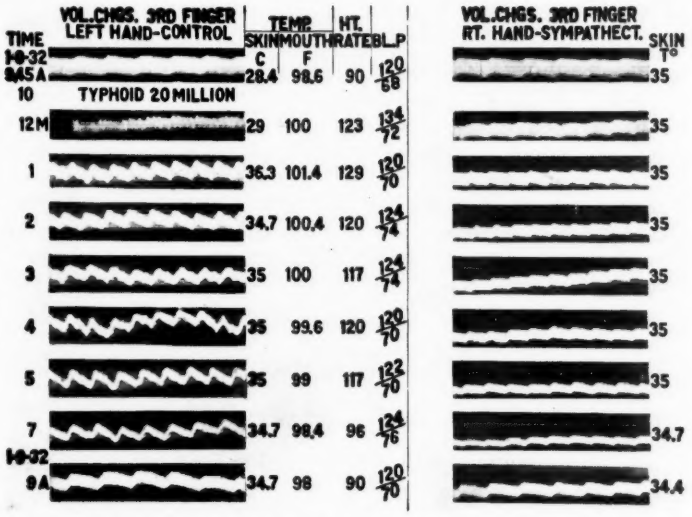

Fig. 3. This figure shows the effect of fever as induced by foreign protein upon the volume changes of the third finger of both hands 1 month after sympathectomy. It is noted that a striking change is obtained in the third finger of the control hand but virtually no change in the volume changes of the third finger of the sympathectomized hand. It is also to be noted that in the control hand skin temperature and heart rate roughly parallel the volume changes of the finger. Very little change was observed in the sympathectomized hand. This indicates that vasodilation of artificially produced fever is of central origin.

The circulatory observations were made by means of a special plethysmograph previously described by Johnson in this issue. By means of this device we were able to make quantitative studies on the circulation in the fingers and note the changes which took place. Measurements of skin temperature were made by the ordinary thermocouple.

The results of the observations will be demonstrated graphically and we shall limit our discussion as much as possible to conclusions from objective experiments.

Figure 1 illustrates the marked increase in pulse volume following sympathectomy and its gradual return to the control level in 21 days. (It will be remembered that in the experimental animal the return of circulation to the control level is in 10 to 14 days (Kuntz); we attribute the variance (21 days) to the more sensitive method we have used.) The skin temperature of the sympathectomized side also increased and has remained increased for 5 months. It is noted from this figure that peripheral pulse volume changes do not parallel the skin temperature changes.

Figure 2 illustrates the effect of local heat to the upper extremities 22 days after sympathectomy. Merely placing the hands in hot water for 10 minutes at 45 degrees C. was sufficient to increase the peripheral pulse volume of the fingers; and this was interpreted to mean vasodilatation. This record illustrates that relaxation of the smaller vessels is possible in the absence of central nervous connections (we are assuming that the ganglionectomy and ramisectomy destroys most if not all the vasoconstrictor fibers to the blood vessels of the right arm).

Figure 3 shows the effect of artificial fever as induced by foreign protein on the volume changes of the fingers 1 month after sympathectomy. In the control arm (left) the volume changes in the fingers, skin temperature, and the body temperature showed a uniform increase in each measurement. In the sympathectomized arm there was no significant change in the peripheral pulse volume or skin temperature. This record suggests that vasodilation from fever in the normal is

Fig. 4. This figure shows photographs of the fingers before and 4 months after sympathectomy of the right hand. The photograph at the left shows the fingers of the right hand before and the right photograph the fingers 4 months after sympathectomy. Note the ulnar deviation of the fingers.

probably of central origin, i.e., from a partial or total paralysis of the sympathetic constrictor tone. Further evidence that this is true is loss of sweating and increased skin temperature early in fever. It also suggests that the sympathetics normally exert a tonic influence over the smaller vessels which are inhibited in fever. The skin temperature of the sympathectomized hand was high and the superimposed fever was insufficient to induce any significant change in the skin temperature.

We were not able to note any appreciable color change of the sympathectomized extremity as reported by other authors. Other findings which we noted were loss of sweating in the operated upon side, a persistent Horner's syndrome, and indefinite changes in the character of the pain. It should be noted here that before operation both hands were moist and cool and since the operation the hand not operated upon has continued to remain moist and cool.

DISCUSSION

We believe that the volume change in the fingers with each heart beat is an index of blood flow to the part. We are fully aware of the criticism that more strictly speaking this method is an index of pulse volume and hence with a dilated vascular bed a greater blood flow could occur without an increase in pulse volume, but we are of the opinion that this is not the case for the following reasons:

1. We were able to produce vasodilation of the sympathectomized vessels by local heat and the amount of vasodilation was about the same as that produced by similar conditions in the control hand. If sympathectomy had produced a permanent maximum dilatation of the vessels, our results would not be so uniform on the control and sympathectomized sides. If there had been any dilatation at all we would expect some difference in response of the two hands following local heat.

2. The results are in keeping with the results of ganglionectomy and ramisectomy on experimental animals. The pre-operative tone is established in 10 to 14 days (Kuntz). It would not be logical to assume that the control of vascular tone in animals (dog) is much different than that of the human.

3. The increased skin temperatures which are said by some authors to be an index of increased blood flow to the part following sympathectomy may be largely or totally due to a loss of part of the heat-regulating mechanism. It is well known that a great deal of the body heat is lost through sweating and an interference with this mechanism may be largely responsible for the increased local heat observed following sympathectomy. Furthermore, we have experiments by this method to show that in fever, in certain cases there is an increased temperature of the fingers but the circulation was markedly decreased as measured by the plethysmograph records, a marked fall in blood pressure and severe pain to the part. (This was in a case of Buerger's disease and will appear in a later report.)

4. This patient did not improve following sympathectomy alone. She was not given any

other treatment for 3 months in an attempt to evaluate this method of treatment for rheumatoid arthritis. As a matter of fact, the photographs before and after sympathectomy indicate that the sympathectomized side became worse. This is not good evidence of a permanent increased blood flow.

SUMMARY AND CONCLUSIONS

By means of a new method we have shown changes in circulation following sympathectomy which suggest the following conclusions:

1. There is an early relaxation of the vessels.

2. There is a progressive recovery of independent tone of these vessels so that the circulation has reached its pre-operative level in 21 days.

3. This indicates that normally the sympathetic exerts a tonic constrictor control over the smaller vessels.

4. Local relaxation of the blood vessels to local heat is subject to little or no central control.

5. Fever causes an early temporary inhibition of vasoconstrictor tone which accounts for the vasodilation observed. If there is a marked fall in blood pressure, the potential vasodilation will not manifest itself peripherally. The detailed explanation of this may be anticipated from the results on the effect of amyl nitrite on the circulation (Johnson).

6. We believe the methods used in this study to be a more accurate index of circulatory change than skin temperature and supplies a simple method for further studies.

7. Our experiments in this case do not show a permanent increased peripheral circulation following ganglionectomy and ramisectomy and are in accord with results of animal experiments. We feel that the increased heat to the part following ganglionectomy and ramisectomy is due to the loss of sweating, evaporation, and possibly other minor unknown factors. The contrasting skin temperatures of the two arms in this case are probably due to the fact that one hand is practically always wet with perspiration; the other dry.

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CLINICAL SURGERY

TECHNIQUE OF OPERATION FOR CANCER OF THE FEMALE BREAST[1]

End-Results in One Hundred and Twenty-nine Cases Seven Years after Operation

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MY original operation for cancer of the female breast has been described many times previously and has become known to many surgeons as the "Jackson flap operation." As a matter of fact, the discovery of the flap was an accident incident to our main purpose, which was to bring the skin from below the pectoral fold up around the axillary vessels and thus to obliterate the axillary fossa. When this was done it was found that the skin from the front of the pectoralis was no longer needed there, so it was slid over to cover the denuded area left when the breast was removed. While the obliteration of the axillary fossa was our main purpose, at the time the plastic flap seemed valuable. Later, however, in the course of our experience, we came upon a case in which the tumor was so far up in the outer quadrant of the breast as to involve the skin which would be used for the flap, and we were forced to abandon its use. We, therefore, evolved another method which is applicable to all cases and which still preserves the main feature of the original operation, namely the obliteration of the axillary fossa. We now use this method most of the time.

In the meantime we had become familiar with what could be accomplished by extensive undercutting of flaps and were able to close the much more extensive wound quite readily. This method I desire now to present with certain other details which either facilitate our work or, more important, probably contribute much to end-results. We shall describe our present operation in detail.

TECHNIQUE

First we have found that the use of a flat top instrument stand on which the patient's arm can rest, disposes of an extra assistant and as well furnishes a conveniently accessible place for surplus instruments. Also, we use heavy bath towels for draping the area as they stay in place and in addition make a warm covering for the chest. With the chest prepared by whatever method, the arm of the affected side is first drawn to the opposite side, thus rotating the patient's body. A large bath towel is then placed beneath the shoulder and chest area and is allowed to hang over the edge of operating table. The arm is then brought back, at right angles to the body, on the instrument table, which is covered with two large towels. The superficial towel is wrapped around the patient's arm from shoulder to below the finger tips and is secured with towel clips, while the other towel furnishes a sterile base for instruments. Another large towel is placed across the patient's body with its upper end at the level of the umbilicus. A vertical towel is then placed with its inner margin at the median line of the body and covers the entire opposite side of chest up to the chin. Finally, a towel is made to cover the anæsthetic frame to which it is fixed by towel clips. The angles of contact of the towels are also fixed with clips. Finally, the lower portion of the body is covered with the usual laparotomy sheet. The entire chest of the affected side is thus left exposed for the extensive dissection which is to follow.

We are convinced that, in many instances, the cancer can be *disseminated* by excessive manipulation and squeezing of the diseased breast in the course of the operative procedure. We, therefore, insist that no manipulation of the breast be permitted; instead we seize the nipple with a large double tenaculum or volsellum by means of which the breast can be drawn about without compression during the operative manipulation.

The lower point of insertion of the pectoralis major to the humerus is located as the point from which to start the incision. From this point the incision is carried upward with a slight upward convexity over to about two fingers' breadth below the middle of clavicle. It is then curved downward to the inner side of the breast and thence down vertically to the level of the umbilicus. By undercutting a flap is raised to the inner and upper side of this incision. The flap should consist of skin and subcutaneous fat down to the depth of underlying fascia. The full blood supply is thus

[1]Presented before the Western Surgical Association, Denver, Colorado, December 4–5, 1931.

preserved and as flap is thick it also provides subsequent plasticity so that the skin itself does not become fixed to the ribs. This flap is undercut beyond the median line vertically and up to the level of clavicle above. Of course it is assumed that all vessels are clamped as divided and this feature is therefore not further discussed—we pay slight attention to small oozing vessels at this time, however. The fairly large flap is thus raised.

We believe that in many instances leaking cells may come in contact with tissues left behind and become the focus of subsequent local implantation recurrences. We, therefore, deal with a cancer wound as we would with a wound in the presence of an acute infectious process from which we desire to protect the exposed area from *contamination*. The flap is therefore immediately covered with a large bath towel wrung from very hot water. Besides protecting the flap, small oozing spots close under the heat and we thus save much time otherwise consumed in trying to check and ligate every oozing spot.

We now return to the starting point for the lower portion of flap. Here the incision follows the edge of the axillary fold to the chest, skirts the edge of the breast with its concavity upward, and then turns downward to meet the inner incision near its lower extremity. This flap is likewise undercut about a hand's breadth below and in the axillary line to the edge of the latissimus dorsi behind, the undercutting being made slightly less as the procedure continues up to its starting point in the arm. This flap is now likewise raised and covered with hot bath towels.

We now mark the fibers of the pectoralis major which has been exposed by the raising of the upper

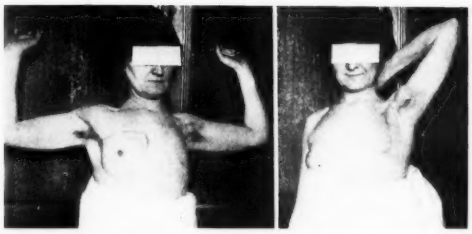

Fig. 1, left. Outline on living patient of incision of original flap operation.

Fig. 2. Appearance in same patient of flap after operation on opposite side.

flap. In the line of the fibers we now separate, with knife or finger tips, the sternal and clavicular portion of the muscles. With the finger, the insertion of sternal portion is isolated and cut across flush with its attachment to humerus. With a curved retractor the clavicular portion is drawn upward and outward. We expose thus the costocorocoid fascia and about its middle we find descending vertically the superior thoracic vessels which are double clamped and divided. The costocorocoid membrane or fascia is incised parallel to the clavicle and, with the index finger, the pectoralis minor muscle is isolated and divided flush with its attachment to the corocoid process. The axillary space is now widely exposed. To the outside of the axillary vessels and nerves and parallel to them an incision is made down to the fixed muscles of the region. This gives a line of cleavage from which with gauze on the finger tip, the loose gland bearing tissues can be brushed off from the front of the vessels. As the brushing process pro-

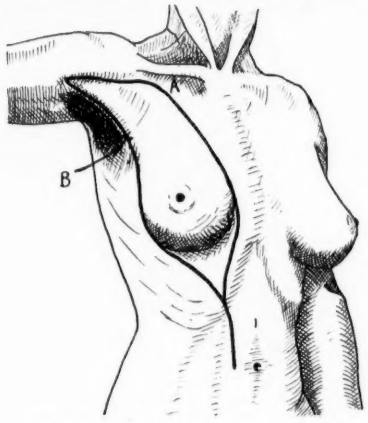

Fig. 3. Outline of incision in non-flap method herein described.

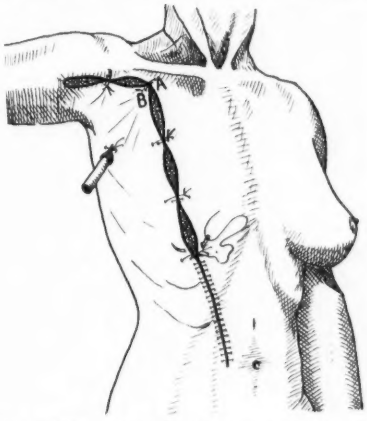

Fig. 4. Outline of method of closure of the wound.

Fig. 5. Appearance of wound before stitches have been removed also illustrating the correct described position of arm following operation.

ceeds inward, the branches of the axillary vessels emerge. The vessels are further isolated with forceps or the blunt point of scissors spread apart. Each vessel is picked up, double clamped, and divided. They may now be ligated if desired or with other vessels left for ligation at the end of the operation. The main trunk of the axillary vein is retracted with a small curved retractor and, with blunt scissors or gauze, the tissues are dissected from beneath the vessels. We divide transversely the fascia over the subscapular muscles and brush this fascia off with gauze. This is the route by which the lymph probably reaches the spine. A vertical incision is then made over the chest wall well back in the recess of the wound and by brushing forward the external intercostal muscles are cleared. The axillary dissection is now completed. We pack the entire area to be left with a hot moist pad and a similar pad is likewise placed over the inner cut surfaces of the muscles and fascia with their now open lymph vessels. This step is taken again to prevent as far as possible contamination from escaped cells.

Our attention is next turned to the lymph circulation. Beginning above, the pectoralis muscle is hooked up with the finger and cut loose flush with its attachment to the sternum. The perforating branches of the internal mammary vessels will be cut and if it is remembered that they pass obliquely down it will facilitate to clamp them a little higher than anticipated. When we finish the separation of the pectoralis below we then excise the fascia covering the upper end of the rectus abdominis. The fascia of the lateral chest region is divided parallel with the reflection of the lower flap and brushed upward. Thus the whole lymph and fascial supply is divided peripherally while the breast is moved about with the volsellum forceps without manipulation. The breast is lifted with the volsellum while the attachment to the chest of the pectoralis minor muscle is divided and finally the whole mass is lifted out. Each raw area after dissection is carefully kept covered with hot packs. We remove these packs in series, ligating divided vessels on clamps beneath. Most of the small oozing has been stopped but a review of the entire wound catches any persistent bleeders until the wound is dry. Some muscle oozers can be better caught in a figure-of-eight mattress suture if the exact source of bleeding is indefinite.

With the dissection complete and bleeding controlled and after all our precautionary measures,

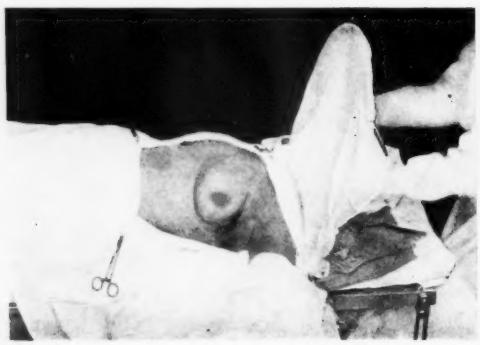

Fig. 6. Draping the field of operation.

Fig. 7. Gauze spica applied to chest and arm in position in which the arm is maintained.

we still may fear that there may yet be loose cancer cells in the wound so we treat cancer wounds as we treat no others: from a large pitcher of hot water we thoroughly irrigate the entire wound while cleansing the surfaces with gauze. We feel that this step gives better assurance that no loose cells will be left in the wound for local implantation and recurrent local growth.

We are now ready to close the wound. First, the edge of the lower flap about where it strikes the chest is brought up around the axillary vessels to a point just beneath the clavicle, as can be estimated in the illustrations. These two points are caught together with a double tenaculum. The remainder of the wound is approximated in similar manner with five or six tenacula at appropriate intervals. As these are segmentally applied it will be found remarkable how the enormous wound is gradually approximated with practically no tension. One by one these tenacula are replaced by figure-of-eight silkworm gut sutures. These sutures enter the skin about 1 inch or more from its margin; cross the wound underneath and are brought out about ¼ inch from the margin of the opposite edge. The stitch is then brought across the wound and re-enters about ¼ inch from this edge. Passing underneath in the wound it finally emerges from within anterior, 1 inch from margin. There is thus a short coapting loop in the skin edge supplemented by an outer tension loop. Of these sutures there are usually from six to eight. Before these sutures are all tied a puncture is made in the lower flap for insertion of a ¼ inch split rubber tube for drainage. This is carried to the upper depth of the axilla and is fastened by suture at the point of emergence.

The wound is now closed by either continuous interlocking or separate sutures, as preferred. For a wound dressing we employ the heavy towels, wrung out of hot water, and applied over chest. The capillarity of the dressing is favored by the moisture so that all wound drainage is delivered to the surface while the skin wound remains dry and clean. This dressing is held in place by a wide gauze bandage applied around the chest and as a spica at shoulder. The bandage is applied snugly to hold the flap in close contact with chest wall. This bandage is applied with the arm in a vertical position and the patient goes to bed with the arm above her head. This position is maintained and in 24 hours the patient is made to use the arm. This position and use of the arm assures a rapid restoration of full use of arm, while if the patient is dressed with the arm down she has difficulty afterward in getting it up and thus has long continued disability.

While this is apparently a minor point we have found it to be, instead, a maximum one with the patient in the utility of the arm. We expect the patient in 2 weeks to be freely able to use the arm in every direction as well as she did before the operation.

SOME FACTS CONCERNING ONE HUNDRED TWENTY-NINE CASES OF CANCER OF THE BREAST SEVEN YEARS AFTER OPERATION.—JOHN H. OGILVIE, M.D.

The following facts have been gathered from a series of cases of cancer of the breast in the clinic of Dr. Jabez N. Jackson.

We have selected 129 cases running from 1909 to 1924, inclusive. Of the 129 cases 109 were in married women and 20 in single women. The average age of the total group was 44.4 years; 11 per cent of the patients were under 30 years of age; the range of ages being from 17 to 78 years.

The average duration of the disease as denoted by a mass in the breast was 2.4 years; the range in this instance being from 7 days to 8 years. The average age was increased considerably by a number of cases in the 7 and 8 year period.

In 62 instances the mass was in the right breast; in 67 cases in the left breast.

In 72 cases skin fixation was definitely mentioned as a diagnostic feature; 24 cases made no mention of this feature; in 30 cases the skin was said to have no fixation; in 3 cases nothing definite was said about the skin. Among the 72 cases in which skin fixation was present all proved to be carcinomata except 3; 2 of these latter proved to be sarcomata, 1 of the inflammatory type, and 1 proved to be a dermoid with superimposed carcinoma. Of the 30 cases in which skin fixation was definitely mentioned as absent, 29 showed a mass in the breast. In the 1 case in which neither a mass nor fixation of the skin was present there was a lump in the axilla which proved to be malignant from an area in the breast which was not palpated. This patient came in because of pain in the breast.

In the 129 cases pain as a symptom was mentioned only 7 times.

Five cases gave a history of a bloody discharge from the nipple; 2 had sinuses in the breast. Four of these 5 cases showed malignancy of ductal type while 1 showed a sarcoma superimposed upon a dermoid.

Twenty-seven cases had definite involvement of the axillary structures diagnosed preceding operation; 36 had axillary metastases disclosed at operation; 14 showed microscopic metastases not suspected at operation. Fifty-two cases showed no glandular involvement.

Two cases in the group had a mass in the breast for 7 years and showed no glandular involvement.

In 35 cases it was thought the chances for a complete cure were good; in 25 it was thought their chances were bad; in all the rest no opinion was expressed.

Radical amputation was performed in all but 8 cases and in these 8 only local amputation was done. Twenty-two cases were amputated by the flap method but in all the rest the regular radical amputation was done. In those cases in which the flap method was done, the mass was situated so as to allow its use without endangering the end-result.

There were 2 deaths in 129 operative procedures; 1 complicated by thyrotoxicosis and pregnancy; the other patient dying of a postoperative pneumonia with lung abscess.

The pathological features were as follows:

	Cases
Carcinoma	97
Medullary carcinoma	4
Scirrhus carcinoma	16
Sarcoma	5
Doubtful type (carcinoma)	7

Twenty-one cases had combined pathological lesions of the breast.

The recurrences ranged from 1 month to 13 years and 8 months. Curiously enough, the recurrences appear to have occurred in the greater proportion of cases in two general periods; one around the 11 month period and a later period of from 3 to 5 years. The average was slightly more than 2 years.

While it was not possible in all cases to say exactly where the recurrence occurred our percentages are as follows:

	Per cent
Lungs	41
Bones	28
Scar	5
Supraclavicular nodes	10
Nervous system	8

No patients with sarcoma are alive; no patient with medullary carcinoma is alive.

Of the 52 cases showing no metastases 37 patients are alive. Of the 77 cases showing metastases or those who were adjudged poor risks for radical cure, 24 are alive and well. This is a percentage of 31.17 per cent in the latter group.

CONCLUSION

1. No cases of sarcoma of the breast in this series are alive 7 years after the operation.
2. No case of medullary carcinoma is alive 7 years after operation.
3. The chance of cure by radical operation is decreased from two-thirds of the cases to less than one-third when the disease has ceased to be a local process.
4. In a series of 129 cases of malignancy of the breast 61 women are alive 7 years after the operation.

FROM THE HOSPITAL FOR CRIPPLED CHILDREN AND ADULTS

SURGERY OF THE ANKYLOSED JOINT[1]

WILLIS C. CAMPBELL, M.D., F.A.C.S., MEMPHIS, TENNESSEE

ANKYLOSIS is usually regarded as a restriction of the range of joint motion, but the type under consideration at the present time is only that in which the articulation has become so completely destroyed by a pathological process within the joint that no practical motion exists or will such be possible by any manner of conservative treatment. Intra-articular ankylosis may be osseous or fibrous which is only a difference in degree and not of kind. Extra-articular contraction of the soft parts may materially limit joint function, but is not pertinent to the subject except when associated with extensive intra-articular lesions. Strong fibrous ankylosis with adhesions which permit only a few degrees of motion is clinically identical with ankylosis in which there is solid osseous fusion of the articular surfaces, with the exception that when motion persists there is often more or less persistent pain and swelling.

Until the past two decades, there has been no realm of surgery in which all forms of treatment have so completely failed as in the ankylosed joint. In a joint in which the articular surfaces had become fused, no function was possible though the nervous and muscular apparatus remained unimpaired. This was an apparition of failure to the surgeon, until by persistent effort a technique has been developed by which restoration of function can at last be furnished to a fairly high percentage in well selected cases.

Restoration of function is accomplished by an operative procedure known as arthroplasty, which is followed by a well planned after-treatment to induce nature's method of reconstructing a new joint after the normal articulation has been completely destroyed. In order, however, to secure maximum success there are many important factors which must be closely observed, and may be enumerated as follows:

1. Conditions for arthoplasty are more favorable when ankylosis is the result of two causative agents: (a) acute pyogenic infection, (b) trauma.

2. All evidence of acute infection must have subsided for at least 6 months before the institution of operative procedures. This is a well known surgical maxim.

3. Trauma uncomplicated by infection is seldom the cause of ankylosis. Arthoplasty is more often indicated for the relief of pain in those joints in which there is incongruity or blocking of motion by comminuted fractures.

4. In multiple ankyloses as a consequence of an acute pyogenic infection, arthoplasty is indicated and may result in restoration of motion in a number of joints in the same individual. However, the prognosis in any one joint when there are multiple ankyloses is much less favorable than when there is ankylosis of a single joint; ankylosis in other joints obviously inhibits cultivation of function in a reconstructed joint.

5. In ankylosis of a single joint caused by tuberculosis, arthroplasty or any radical measures within the joint are contra-indicated. Undoubtedly, it might be possible to obtain excellent results in some instances but the probability of relighting a latent tuberculous infection and the serious consequence thereof should be sufficient warning.

6. In those rare cases of multiple or bilateral ankyloses, as from tuberculosis of both hips or both knees, arthoplasty may be indicated as the disability is so great that the risk of relighting the tuberculous infection is justified.

7. In recent years there has been an increasing tendency to fuse or arthrodese all tuberculous joints even in children. When osseous fusion has been induced by operation in the early stage of the infection before extensive destructive changes have occurred, the eradication of the pathological process is more probable. In such cases it is conceivable that arthroplasty might be indicated. However, where there have been extensive destructive changes from tuberculosis, arthroplasty should never be considered and even in those with early fusion its advisability is not yet proved.

8. In progressive arthritis of a low grade inflammatory type, as atrophic arthritis, arthroplasty may be attempted after the process has become quiescent or arrested. Relatively good results have been secured but are not comparable with those secured after pyogenic infection or trauma, also there is less chance of restoring function.

9. The position in which ankylosis has occurred is an important factor. When ankylosis occurs in the most useful position for future function, the prognosis is much more favorable than when ankylosis occurs in malposition or luxation.

[1] Read before Section of Orthopedic Surgery, New York Academy of Medicine, February 19, 1932.

10. In those in whom there has been impairment of growth from obliteration of the epiphyses or an excessive diminution in length from loss in continuity caused by the destructive process, restoration of function would not be of sufficient advantage to justify the procedure.

11. Abnormal osseous structure, as demonstrated by the roentgenogram, may be an important factor in determining the prognosis and indications for arthroplasty. The prognosis is less favorable when the structure has been transformed for one or more inches adjacent to the articular surfaces. Old, dense, eburnated bone extending for a considerable distance in the bones forming the articulation, is not a favorable soil for the production of a functional joint. Such a condition usually follows an extensive virulent osteomyelitis and results in low-grade bone tissue which bears the same relation to normal bone that fibrous scar tissue bears to normal soft tissue. Not only is such dense bone poor soil for reconstruction of a joint but the danger of relighting acute infection is grave. In the knee dense bone will not form a satisfactory base for a new articulation and positively contra-indicates arthroplasty. In other joints such bone decreases the chances of success, but is not a contra-indication.

12. The presence of osteoporosis or bone atrophy likewise interferes with the remodeling of the bones for the new articulation. When the position of the part will permit functional use of the member, the bone structures should be restored to normal before arthroplasty is considered. This requires, as a rule, about 6 months of active use of the affected member and also weight bearing in the lower extremity. In those cases in which malposition prevents functional use, osteoporosis persists indefinitely and the structure of the bone can be restored to normal only by special care in gradually inducing function and weight bearing after correction of the deformity.

13. Alterations in the internal structure of the bones caused by a long period of disuse are not favorable to the construction of a new joint. In such cases there may be formation of a medulla or central canal completely transversing the joint and surrounded by cortex which has been developed by the transformation of cancellous bone into dense bone. In this event also sufficient base may not be obtained to form a satisfactory joint. In fact, normal cancellous bone should form the basis of the new articulation. And, further, the restoration of function to muscles which will have become commensurably atrophic will be difficult.

14. The age at which arthoplasty may be attempted varies somewhat in the different joints. The most favorable age is between 18 and 30 though the procedure is permissible and justifiable in many up to the age of 55 years. Age is not so much a question of years as of the character of the tissues of the individual patient. Arthroplasty may be carried out in the jaw and elbow at any reasonable age though in the knee and hip the likelihood of success is lessened as age advances.

15. The prognosis is not favorable in children as the epiphyses may be traumatized at operation and growth arrested or distorted. Callus production and granulation tissue forms more rapidly in children and there is a tendency to early adhesion or fusion. Further, it is difficult to secure the co-operation necessary to induce physiological and functional adaptation in the development of a new joint.

16. The social status and occupation of the individual must be considered; arthroplasty should be employed as a selective measure especially in the weight bearing joints. A stiff joint in a good position is more serviceable in strenuous occupation. In the jaw, the procedure is always indicated as occupation has no bearing.

In fully 95 per cent of those in which the operation is indicated the etiological factor has been a pyogenic infection, the pathology of which in all pyogenic organism is approximately the same, and may be described in three distinct stages, the acute, the subacute, and the residual. As arthroplasty is indicated only in the residual stage, after there has been complete organization of all tissues involved, specimens for study have only been secured under such conditions, and may be described as follows:

If the ankylosis is osseous, microscopical examination will show normal bone tissue.

Microscopical examination of tissue removed from a joint with fibrous ankylosis reveals marked thinning of cartilage in places while in other areas there is hyperplasia. Plugs of fibrous connective tissues have entirely replaced the cartilage in other areas, the latter extending out into the joint space as adhesions. There is considerable osteocartilaginous structure forming a zone between the true cartilage on the joint side and bone below. The cartilage stains poorly and has lost its cellular elements in the superficial portion. The subchondral bone plate is frequently interrupted by plugs of fibrous tissue growing toward the cartilage from the interosseous connective tissue. There is marked bone atrophy and halisteresis and increase of interosseous connective tissue. Cellular elements are numerous in the marrow spaces, and besides the normal forms quite a number of plasma cells and lymphocytes are seen.

As many cases are first observed years after the original pathological process has subsided and after certain affections it is questionable as to the indication for operation, a careful differential diagnosis is essential. This must usually be made from the history and the roentgenogram, and often the history may not be reliable, and dependence must be placed in the roentgenogram alone. The history of an acute infectious process with sudden invasion and high temperature will usually distinguish ankylosis of pyogenic origin. Ankylosis as a complication or sequela of an acute infectious disease is also suggestive of the etiological agent; for example, an acute arthritis during the course of, or subsequent to, pneumonia that runs an intensely septic course is suggestive of pneumococcus infection. A history of prolonged convalescence with the joint remaining intensely painful and irritated for months is suggestive of infection by the gonococcus.

In ankylosis resulting from an extensive osteomyelitis there is also a history of acute onset, there are usually multiple scars, adhesions to the bone, and evidence of old sinuses extending for a considerable distance along the shaft of the bone composing the joint. On examination by palpation there will be massive hypertrophy of the shafts of the bone and often irregularity in contour of the bony surfaces.

In ankylosis resulting from tuberculosis, atrophy of the affected member is usually more pronounced than in other pathological processes. Osseous fusion is uncommon and ankylosis is usually of the fibrous type. Motion is slight and often painful and the patient may complain of joint strain. There is a history of insidious onset with an indefinite course, often extending over several years.

Syphilis seldom causes ankylosis but may induce extensive destructive changes of the articular surfaces, causing pain from incongruity. There will be a history of an indefinite process closely resembling tuberculosis, but the symptoms will be prolonged and without pain until destructive changes occur. The Wassermann test has been found a material aid to diagnosis.

In the atrophic or progressive polyarticular arthritis there is a history of low grade inflammatory process running an indefinite course often extending over months and resulting in painful and deformed joints after the process has subsided. Solid osseous fusion occurs only in the late stage of such affections. The hypertrophic type rarely causes ankylosis, but there is limited motion.

In ankylosis following trauma there will be a history of severe injury followed by a period of disability. There may also be a change in contour of the extremity resulting from a fracture. Bony ankylosis rarely follows trauma of the large joints except the elbow.

X-ray examination. As the history and clinical findings may be obscure the diagnosis of the cause of ankylosis often depends entirely upon the roentgenogram. In ankylosis from any cause the roentgenogram determines the position and relation of the bones forming the articulation, loss in continuity, and character of osseous structure. When not inhibited by massive hypertrophy of bone circumscribing the affected area, the roentgenogram will also demonstrate the pathology in the interior of the joint and adjacent thereto, as destructive areas, osteoporosis, cavities, and sequestra.

In ankylosis resulting from acute pyogenic infection the manifestations in bone are confined to the articular surfaces and to the subadjacent bone. At the end of 3 to 6 months after the subsidence of all symptoms, the joint line may be plainly visible but narrower than normal; the extremities of the bones will show extensive osteoporosis with a very thin cortex. If the process ceases at this point, a fibrous ankylosis may result in which a line of cleavage will be permanently apparent, but more frequently there is a gradual ossification until osseous fusion of the articular surfaces is complete with an increase in density beneath the articular surfaces. Coincidentally with the intra-articular ossification there is a gradual increase in structural density and condensation of the spongy bone with slight hypertrophy in the extremities of all bones composing the joint. Also there may be a slight proliferation of the periosteum for a considerable distance along the shafts of the bones. Such hypertrophic changes cause the joint to stand out in marked contrast to the surrounding soft tissues.

In ankylosis resulting from acute infectious osteomyelitis the etiological factor may be the same pyogenic organism which may cause acute infectious arthritis but the process is diffused throughout the joint and the entire, or part of the, shafts of the bones comprising the articulation. There is massive hypertrophy of the extremities and shafts with marked increase in density which is characteristic. Even though the causative agent in osteomyelitis and arthritis is identical, the indications for operation in certain joints are totally different in the two conditions as above emphasized.

The X-ray rarely demonstrates osseous fusion in tuberculosis. There will be definite irregular dark areas of destruction and often destructive

changes along the joint space which are most suggestive.

In low grade infectious arthritis, osseous ankylosis is exceedingly rare. The process often terminates in extensive destructive changes with hypertrophy and erosion of the joint surfaces, though seldom in solid fusion; ankylosis is usually fibrous. Differentiation may not be possible by the roentgenogram from acute pyogenic infections of a mild degree or from a typical tuberculous joint, until exploration is made. The roentgenological appearance in syphilitic arthritis is well known and characteristic.

In arthritis of the hypertrophic type or osteoarthritis, the roentgenogram may show extensive bone proliferation characterized by osteophytes. In the atrophic type or progressive polyarticular arthritis, the process is always polyarticular and characterized by atrophic and ossifying changes by which the diagnosis can usually be made.

When ankylosis is the result of trauma the roentgenogram will demonstrate irregular callus formation and evidence of former fracture.

In literature there is often confusion between arthroplasty and excision especially in the elbow joint. Excision is merely the removal of sufficient bone to induce a pseudo-arthrosis, whereas arthroplasty is the reconstruction of all the component parts essential to function. The operative technique of arthroplasty may be divided into (1) the plastic adjustment of the soft parts, (2) the reconstruction of bone, (3) the interposition of tissue.

The plastic adjustment of soft parts. In planning the operation the position in which ankylosis has occurred must be taken into consideration as well as the relation of the articular surfaces and the contractures of tendons, fasciæ, nerves, and vessels. Undue tension must not be placed on the nerves and vessels in correcting malposition; the tendons, fasciæ, and capsules must be lengthened by plastic adjustment when contracted to permit free function of the articulation. The object should be the re-arrangement of all contracted soft tissues to comply with the demands of restoration of function. Active function will be reestablished earlier if all structures are conserved. No tissue should be dissected unnecessarily; usually tendons should not be divided until the bone has been severed, as often very large tendons may be of sufficient length to permit a fair range of motion after all scar tissue has been removed, and the articular surfaces are remodeled.

As in the bones great care should be taken to impair the circulation to the articular surfaces as little as possible. Stripping of the periosteum with soft tissue attachment in order to correct deformity is to be especially avoided, as irregularities from aseptic sequestra may later occur and defeat the purpose of the operation. If deformity cannot be corrected by severance of the extra-articular tissues and capsule a two stage operation is indicated.

Reconstruction of the bone. The fusion of the bones, whether osseous or fibrous, should be entirely severed under direct inspection. Great force should not be used in separating the articular surfaces as crushing of the surfaces and fractures may occur. The amount of bone removed varies in each joint and according to the different conditions found in the same joint. An amount should be excised sufficient to permit easy play of the joint on manual traction, though under no circumstances, regardless of the contracture of the part, should excision be so extensive as to prevent the formation of an adequate foundation for satisfactory articulation. For example, should all the expanded lower extremity and condyles be removed from the humerus, only the shaft would articulate with the bones of the forearm and a flail pseudo-arthrosis would result. This, in reality, would be an excision and not an arthroplasty.

The technique varies as does the mechanism of the joints. In some of the joints it is best to reconstruct a more simple articulation than the original normal joint. For instance, in the knee, the integrity of the spine, shallow tuberosities of the tibia, and the condyles and intercondylar notch of the femur cannot be so well maintained as the construction of a simple hinge joint with one condyle and one shallow recurring tuberosity. In such a joint as the hip the normal ball and socket is the simplest and should be employed when possible.

Interposition of tissue. It is possible to restore function without interposition of tissue between the articular surfaces, but the chances of success are much less than when no material is interposed, as has been demonstrated by experience. The object of interposing material is not alone to prevent union of the surfaces but to induce the formation of a new synovial membrane, or substitute therefor. In consequence a double layer or sack should be placed between the articular surfaces, and so anchored as to permit free play of the articulation within normal range. This thus reproduces the primary embryological joint. Undoubtedly in the past, failure has often been due to efforts made solely to prevent fusion without due consideration of physiological principles. The material interposed should be autogenous, the most adaptable from the standpoint of tolerance and texture is undoubtedly the fascia lata from

the outer aspect of the thigh just above the knee, where a sheet of sufficient dimensions can always be secured. In some of the smaller joints, however, as the fingers and small wrists the fascia may be taken from the inner aspect of the thigh where it is much finer and thinner. The fascia should be interposed with the rough external surface applied to the raw surface of the bone, while the smooth, glistening, internal surface lines the interior of the joint. The loose areolar tissue applied directly to the open marrow spaces of raw bone is thus conducive to early vascularization, while the smooth deeper surface permits early movement of the articular surfaces.

A microscopic examination of the fascia lata demonstrates that the deep smooth fibers are closely packed resembling tendon tissue, which becomes more loosely constructed as the outer surface is approached. A fluid is observed beneath the fascia on removal which permits the free play of the muscles, but this must be normal lymph as no endothelial cells could be demonstrated on the deeper surface.

The technique in the different joints has been previously described in former contributions; in those joints more adaptable to arthoplasty, in consequence only a general discussion of some of the important details will be considered. In the jaw no material is interposed and the operation is more of an excision as the normal condyle and ramus maintain the space after removal of bone when only one side is involved, and when bilateral the force of gravity acts in the same manner. In all other joints the double layer of fascia is interposed as already described. In the knee joint a portion of the posterior crucial ligament can usually be conserved which maintains circulation to the internal condyle. Great care should be taken not to interfere with the circulation to the external condyle by stripping posteriorly the periosteum and soft parts from the bone and severing the external ligamentous attachment. After the operation the internal lateral ligament may be elongated, and should be shortened by a mattress suture. Also in the knee it has been found unnecessary to sever the quadriceps tendon, as sufficient space is maintained for joint function after the usual amount of bone has been removed and the surfaces reconstructed. In the hip joint the ligamentum teres must be severed, but the operation should be carried out through the Smith-Petersen incision without stripping the attachments of the capsule from the neck, thus preserving the circulation from the so called epiphyseal and periosteal vessels. It has been found that wide exposure with removal of soft tissues may cause necrosis of the head with later dissolution unless these principles are meticulously carried out. The head should also be made as large as commensurate with the bone which remains.

In the ankle and in other joints, as the shoulder, when compensatory function was possible arthroplasty has not been employed except when adjacent articulations were also ankylosed, but in recent years arthroplasty has been successfully employed in three ankles in which only that joint was the victim of bony ankylosis. The operation was carried out by a long external lateral incision with the interposition of a double layer fixed by suture to the posterior capsule. So far these patients have not complained of pain and a sufficient degree of motion was secured to restore elasticity to the gait, which was approximatly 20 to 30 degrees. Arthroplasty of the fingers has not restored the free movements desired, but in some instances there has been material improvement, possibly 50 per cent of function.

The *after-treatment* is most important and is instituted within one week by inducing voluntary muscular action as contracting the quadriceps muscle. At the end of 2 weeks active and passive motion is continuously induced and gradually increased. Care is taken that active motion is commensurate with passive motion, as it is possible to cause excessive movements, with stretching of important ligaments and false motion. Also the structure of the bone must be restored to normal as function is increased, as there may be compression of osseous surfaces in which osteoporosis persists. In the weight bearing joint this is accomplished by apparatus which gradually permits the weight of the body on the part to be increased. Even after apparatus has been discarded more vigorous exercises should be enforced to cause further condensation of the bone, as in four knees there was a subsequent fracture of the lower extremity of the femur from comparatively slight trauma, but this can and should be avoided by observing the physiological principle of functional adaptation. In these cases the fracture had healed without further impairment of function or complication.

As previously stated, unless a joint can be restored in which there is approximately normal endurance, a stiff joint in a good position is more serviceable; however, nearly normal joints can and have been secured in a sufficient number of cases, as previously reported as to the end-results in individual joints, to justify the procedure.

There has been much speculation as to the nature of a joint after the evolutionary process of

reconstruction following arthoplasty, and this factor was demonstrated in the Sir Robert Jones Lecture, October 18, 1930. Conclusions were drawn from several factors which may be enumerated as follows: (1) "spontaneous arthroplasty" after destructive processes in joints; (2) ununited fractures; (3) successive roentgenograms after arthroplasty; (4) biopsy of joints in which function had been secured by arthroplasty.

"Spontaneous arthroplasty" is the reconstruction of a joint by natural processes of repair, after the joint has been completely destroyed. Such a termination of an acute infectious process is not infrequently observed, especially in the hip joint, as illustrated by the following case history.

A woman, aged 45 years, applied for treatment at the Hospital for Crippled Adults, on account of disability and pain in the hip joint which resulted from an acute infectious arthritis occurring at the age of 15. The patient walked with a decided limp; the left hip was flexed 150 degrees. There was about 50 degrees free motion in all directions. The roentgenogram demonstrated a very irregular joint with marked proliferation and condensation. The diagnosis was the residual stage of acute infectious arthritis, with subsequent osteo-arthritis, due to constant use of an incongruous joint. An arthroplasty was performed October 4, 1928. On incision into the joint, the acetabulum and head of the femur were found to be irregular; there was osteophytic formation about the margins and scattered areas of degeneration and fibrillation of the cartilage. The ligamentum teres had entirely disappeared, the synovial membrane was largely substituted by an invasion of fibrous tissue. The microscopic examination of a specimen removed from the acetabulum and from the head of the femur demonstrated a layer of dense fibrous connective tissue beneath which was a layer of fibrocartilage. There were definite degenerative changes in the cartilage; beneath the cartilage was the supporting normal spongy bone.

Sections were also made from a number of ununited fractures with pseudo-arthrosis excised at the operation. The tissue structure is almost identical to that in a spontaneous arthroplasty. There are three more or less defined strata, namely, from within outward a dense fibrous layer, a stratum of atypical cartilage, and the supporting bone. The articular surface apparently arises from two sources; the exposed marrow spaces and the transplanted fascia lata if the latter remains viable; otherwise from the marrow alone. As cartilage cells have been demonstrated in the deeper layers of the synovia and capsule, it is possible that the articular surfaces could be derived from that source.

Biopsy has been carried out in a number of joints varying from 6 to 18 months after arthroplasty, which demonstrated approximately the same process as after spontaneous arthroplasty and ununited fracture. The capsule at the end of one year is much thicker than normal, and the joint cavity approximately one-half the size of the normal joint. There is usually joint fluid present. The surface may be covered with a layer of tissue very closely resembling the interposed fascia lata. A section from the surface demonstrated by the microscope a superficial layer of dense fibrous tissue with a vascular supply which appeared to be the interposed fascia lata, or a substitute therefor. Beneath this is a layer of cartilage which is supported by spongy bone. The superficial layer is approximately from 50 to 100 microns in thickness; the fibrocartilaginous layer is approximately from 500 to 1,000 microns in thickness; the osseous layer is, of course, continuous with the osseous structure of the bones which comprise the articulation. In one case synovial villi were demonstrated, but this could not be accepted as conclusive as it may have been the remains of the former normal joint. In some of the cases examined there were several bursæ or hygromata and in some there were fibrous adhesions across the articular surfaces. In those, after the lapse of one year the fibrous layer showed evidence of disappearance by absorption and substitution of fibrocartilage so that in time the entire joint was invested by a layer of more or less atypical articular cartilage.

In spontaneous arthroplasty, pseudo-arthrosis, and often arthroplasty, the evolutionary process is approximately the same and is brought about by friction between osseous surfaces. A pseudo-arthrosis differs materially from an arthroplasty or from a joint which nature has salvaged by spontaneous arthroplasty, in that there is no muscular apparatus especially arranged to secure function. Evidently, however, free movement with friction induces the same process.

Wherever motion can be maintained between osseous surfaces, there will develop an evolutionary process of healing with the formation of a new joint which is nature's method of repair. As time advances the tissues will become, from usage, more highly specialized. The fascia lata, in all probability, entirely disappears, or is substituted by dense fibrocartilage, but it is very doubtful whether true hyaline cartilage is ever reproduced. Thus the process is simply nature's method of repair, and arthroplasty must be regarded as a method which may induce normal reparative process.

Roentgenograms. Much information can be secured by successive roentgenograms after arthroplasty. About 200 films of arthroplasties have been reviewed, the intervals at which they were taken ranging from 1 to 10 years after operation. There are some variations in findings, depending upon the function of the joints in question. The

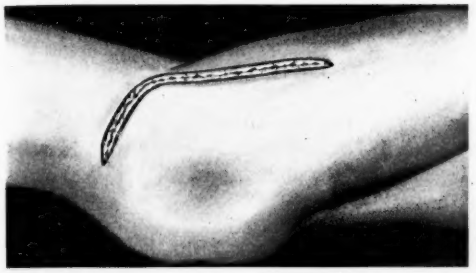

Fig. 1. Skin incision for arthoplasty of hip.

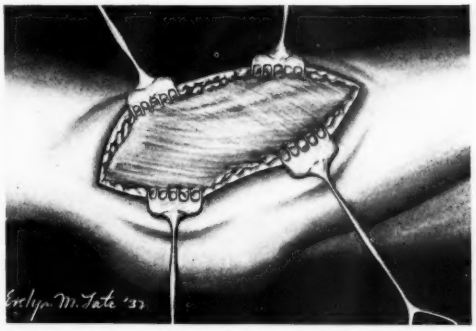

Fig. 2. Exposure of muscles.

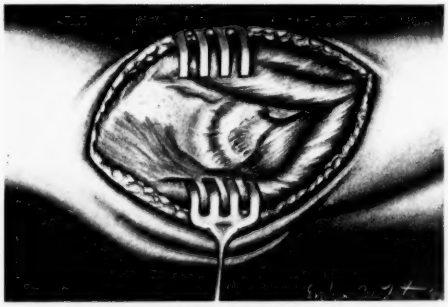

Fig. 3. Complete exposure of ankylosed hip, care being used not to remove any more attachments of the soft tissues about the neck of the femur than is absolutely necessary.

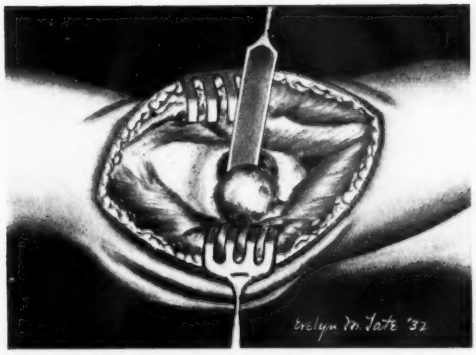

Fig. 4. Excision of ankylosis and removal of the head, care being used to alter the contour of the head as little as possible.

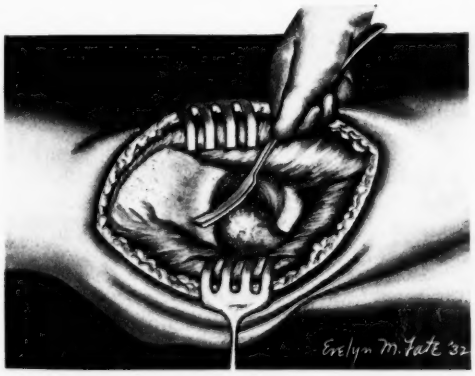

Fig. 5. Smoothing off the head with rasp, leaving the head large and globular.

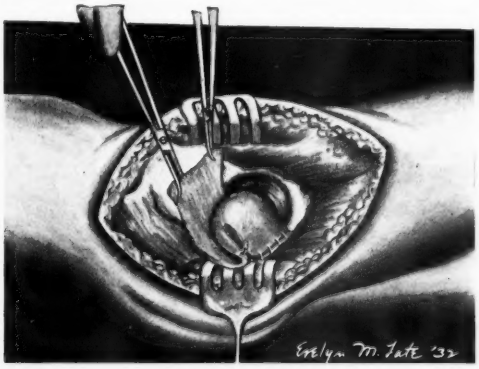

Fig. 6. Interposition of free fascia lata placed to cover the head and acetabulum, thus making a double layer or practically closed sac when the reduction is made.

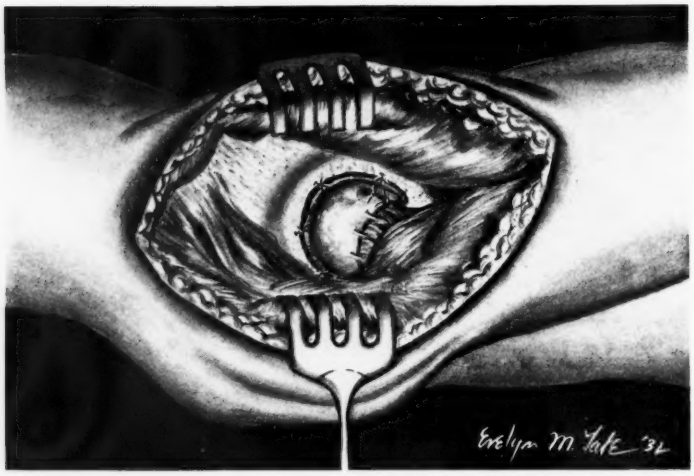

Fig. 7. Complete reduction; new joint completely lined with fascia lata.

evolution of functional adaptation, as would naturally be expected, is more pronounced in the knee and the hip than in the non-weight-bearing joints. The dimension of the joint space is less than normal, especially in weight bearing joints. The relation of the articular surfaces to each other remains unchanged, except in a small number in which the stamina of the ligaments was impaired and in those in which gross irregularities had occurred. In a majority, the contour of the articular surface was even and smooth; in some there was a definite irregularity. In a small number of knees there was a punched-out area or cavity on the lateral aspect of the articular surfaces of the femur corresponding to the normal external condyle. In two or three there were similar but less marked changes in the lateral half of the articular surfaces on the tuberosity of the tibia. Gross irregularities in the head of the femur were occasionally observed, and in one instance there was total disappearance of the head and neck. Compression of the articular surfaces was also present at times. Those gross irregularities described were probably due to impairment in circulation at the time of operation. Successive roentgenograms demonstrated compression of the articular surfaces to be due to functional use, as weight bearing, before the structure of the bone had been sufficiently restored. In joints not bearing weight unrestricted use with impaired ligaments may also cause such irregularity, but not to the extent demonstrated in the lower extremities. As has been proved by experience, these defects can be obviated largely by avoiding impairment of circulation at operation, by properly regulated use and by restricted weight bearing until the structure of the bone and the musculature has been restored.

Fig. 8, left. Bony ankylosis of hip following infectious arthritis.

Fig. 9. Same as Figure 8, 4 years after arthroplasty. The contour of the head of the femur and the acetabulum is well adapted for excellent function and the range of motion is practically normal.

The structural changes after arthroplasty are as follows: At the end of 3 weeks osteoporosis is present, as denoted by the characteristic mottling, which gradually increases until the effect of active use is apparent, which is usually in about 3 months. At this time there is gradual restoration of structure as denoted by the appearance of new bone trabeculæ. At the end of 1 year the bone structure should be approximately normal. About this

Fig. 10. Roentgenogram of hip, 3 years after arthroplasty. Note the irregularity in contour of the head of the femur which has occurred as the result of aseptic necrosis. Function of the joint, however, is excellent.

Fig. 11. Roentgenogram of hip, 12 years after arthroplasty. There is considerable new bone proliferation about the joint which, however, does not interfere with good function.

time, approximately one-fourth of an inch below the articular surface, there appears a fine line of condensation with bone trabeculæ at right angles to the shaft; this gradually increases for the ensuing year, after which it remains stationary. This is probably the index that restoration has been accomplished as far as possible. As years go by, the rearrangement of the osseous trabeculæ, along the new lines of pressure becomes evident as in normal extremities. Of course, there is no arbitrary period for such development, which largely depends upon the co-operation and the muscular resources of the individual.

Pronounced bone proliferation, as evidenced by formation of outgrowth from the articular margins or osteophytes, was present in approximately 40 per cent. In 25 per cent there was only slight

Fig. 12. Fig. 13. Fig. 14.

Fig. 12. Bony ankylosis of knee following acute infectious arthritis.
Fig. 13. Same case as in Figure 12, 3 years after arthroplasty. Anteroposterior view.
Fig. 14. Same as in Figure 12, lateral view. Note regularity in contour of articular surfaces.

Figs. 15 and 16. Roentgenogram of knee 3 years after arthroplasty. Anteroposterior and lateral views. A portion of the external condyle of the femur has been absorbed leaving a large defect. The stability of the joint is good and the clinical result excellent.

Figs. 17 and 18. Roentgenogram of knee 2 years after arthroplasty. Anteroposterior and lateral views. The articular surfaces are irregular and there are hypertrophic changes in the new joint. The knee is stable, freely movable, and painless.

proliferation and in 35 per cent no reaction whatsoever. This reaction depends entirely upon the extent and the degree of involvement of bone by a pyogenic process; in other words, on the degree of osteomyelitis, as evidenced by condensation of bone. In those patients in whom the infection was entirely confined to the joint and the structures of the bone had remained normal, there was no reaction. This reaction, however, does not bear any material relation to the functional result unless there has been an extensive osteomyelitis. In many apparently normal or serviceable joints, after various pathological processes, such changes are known to occur and are frequently observed.

The stamina of the contour of the articular surfaces, as illustrated by the gross irregularities observed in the roentgenogram, is due to impairment of circulation, bone atrophy or osteoporosis and impairment in quality of the bone structure. The articular extremities being free, the blood supply is derived solely from the attachment of the adjacent soft structures. The joint surfaces do receive slight nourishment from joint fluid, but not sufficient to have an appreciable effect. During operation, if there is gross detachment of the bone from the soft structures, circulation will be impaired and areas of the articular surfaces may undergo aseptic necrosis with sequestration or absorption; on the other hand, the soft structures may be reattached with reestablishment of the blood supply before such occurrences take place. There is a close analogy to the loose bodies in joints, the bone graft, and terminal fractures in extremities. The loose body, especially the type caused by the condition known as osteochondritis dissecans, is in all probability, due to trauma impairing circulation to the arteria media in the posterior crucial ligament, which supplies a small area on the internal condyle of the femur. By aseptic necrosis a particle of bone with cartilaginous investment is exfoliated into the joint. A cross section of this body, after it has remained in the joint for a long period of time, will show living tissue on the exterior but necrosis within; it has received nourishment only from the joint fluid. However, if by chance the loose body becomes attached to a villus or a fold in the synovial membrane, the particle becomes revascularized, there being more rapid proliferation and restoration of the interior. The bone graft also depends on early revascularization in the same manner, if function is to be restored. Terminal fractures often do not unite, as illustrated by the frequent occurrence of non-union in such locations as the neck of the femur and the external condyle of the humerus. This non-union is caused by the severance of the circulation by fracture and the fact that a large portion of the terminal fragment, the articular surface, is devoid of blood supply.

The gross irregularities after arthroplasty, demonstrated by the roentgenogram, are not always incompatible with excellent function, as often observed. Similar irregularities in joints of good function are demonstrable often, for example: after a loose body caused by osteochondritis dis-

secans has been removed, a large cavity may remain in the internal condyle of the femur without impairing function; also it is possible that many of the irregularities observed in the roentgenogram may be filled in with dense fibrous tissue, the defect being more apparent than real. Unfortunately, no opportunity has been offered to prove, by biopsy, the status of such joints.

Depression of the articular surfaces as a result of too early compression by weight bearing has been observed, but can be prevented by the routine after-treatment as described. In those cases in which the quality of the bone is deficient, as manifested by excessive condensation, sequestration and disintegration, joint irregularity may occur regardless of the after treatment. Unless, however, this irregularity is excessive, it is usually not incompatible with good function.

As a basis of this discussion the records of 325 arthroplasties have been reviewed. The results in the more favorable joints have been previously reported, which, however, cannot be estimated grossly as there are numerous factors, as previously enumerated, which may affect the individual case, for instance, malformation, impairment of structure and causative agents, and also the evaluation of these results must be made in terms of function and endurance and not mere motion. Sufficient time has elapsed to denote the effect of wear and tear of actual usage in some instances as long as 15 years since operation. In 1927, I made a painstaking analysis of 22 knees in which good function had been secured and in which from −3 to 8 years had elapsed since operation. Since that time these cases have continued in the same status. The type of joint secured cannot be regarded as a reproduction of the normal articulation but an excellent substitute which will often replace to a satisfactory degree normal function and endurance and in many instances decrease severe disability.

In conclusion I desire to emphasize the gradual evolution in operative technique to conform to the physiological principles involved. This is well illustrated in arthroplasty of the hip and knee. The operation must be carried out with minimum impairment of circulation, in consequence the procedure must be so planned that the soft parts are detached as little as possible from the articular extremities. These principles are not alone involved in arthroplasty but in all surgery of bones and joints.

FRACTURES OF THE METACARPALS AND THE PHALANGES

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FOR some time we have been impressed by the constancy of the deformities which follow fractures of the metacarpals and the phalanges. An analytical study of 1,323 such fractures occurring in our practice has served to verify this impression and we believe that our study may be of interest to others who meet many such injuries in their practices. In our group, the fractures were distributed as follows:

	Cases	Per cent
Distal phalanx	822	62
Middle phalanx	221	17
Proximal phalanx	189	14
Metacarpals	91	7

More progress will probably be made in the treatment of the fractures of the metacarpals and the phalanges when the same consideration is given to these small bones as is given to the long bones of the body. At the outset, therefore, we wish to present the functional anatomy involved in fractures of the metacarpals and the phalanges since a knowledge of the muscular attachments is most important in their successful management. There are several muscle groups involved in the movements of the bones of the hand.

Movements of the fingers. Two separate series of movements occur in relation to the articulations of the fingers: flexion and extension (at the metacarpophalangeal and interphalangeal joints), and abduction and adduction (only at the metacarpophalangeal joints). The movements and the muscles concerned are given in the following tables:

Flexion	Extension
Flexor digitorum sublimis	Extensor digitorum communis
Flexor digitorum profundus	Extensor indicis proprius
Lumbricales, Interossei: Acting on the metacarpophalangeal articulations	Extensor digiti quinti proprius
Flexor digiti quinti brevis	Lumbricales: Acting on the interphalangeal articulations

Abduction	Adduction
Flexor brevis and Opponens digiti quinti: from the medial side of the hand	Volar interossei: to the midline of the middle finger
Dorsal interossei: from the midline of the middle finger	

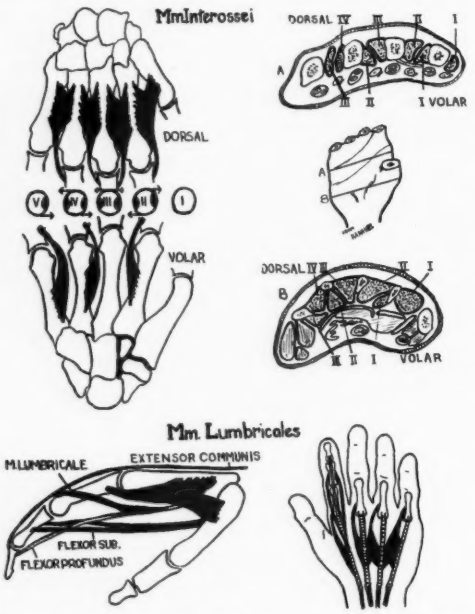

Fig. 1. Arrangement of intrinsic musculature of the hand.

Flexion is more powerful and complete than extension of the fingers. The flexor digitorum profundus alone acts on the terminal phalanges; the flexor sublimis and the flexor profundus together flex the proximal interphalangeal joint; flexion of the metacarpophalangeal joint is affected by these muscles assisted by the interossei, lumbricales, and flexor digiti quinti brevis. Extension of the phalanges is brought about by the united action of the extensors of the digits, the interossei, and lumbricales. Extension of the fingers at the metacarpophalangeal joints is produced solely by the long extensor muscles. Separate extension of the index finger only is possible; the three inner fingers can be completely extended together only because of the connecting bands joining the extensor tendons on the back of the hand.

The arrangement of the interossei and lumbrical muscles and the insertions of the flexor and extensor tendons are illustrated in Fig. 1.

Fractures of the distal phalanx. The terminal phalanx is attached only at its proximal end to the middle phalanx. Its distal portion is free and not subject to the action of either the intrinsic or extrinsic muscles. It is here that considerable crushing of fragments may occur with but slight displacement (Fig. 2a). Fractures involving the

proximal portion of the terminal phalanx are subject to the action of the flexor profundus tendon and the extensor communis tendon. A fracture here may develop a varying degree of dorsal displacement of the proximal fragment (Fig. 2b). Occasionally, the entire proximal fragment may be evulsed (Fig. 2c).

Fractures of the middle phalanx. Fractures of the middle phalanx owe their displacements to the action of the flexor digitorum sublimis. This muscle ends in a tendon which separates into two portions, which insert one on either side of the

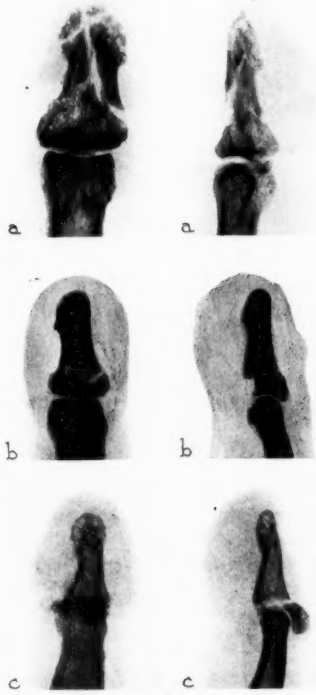

Fig. 2. Fractures of the distal phalanx.

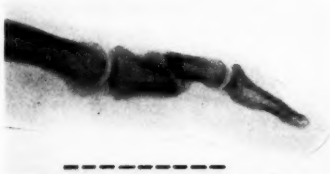

Fig. 4. Volar spur resulting from fixation of fractured middle phalanx on a straight splint.

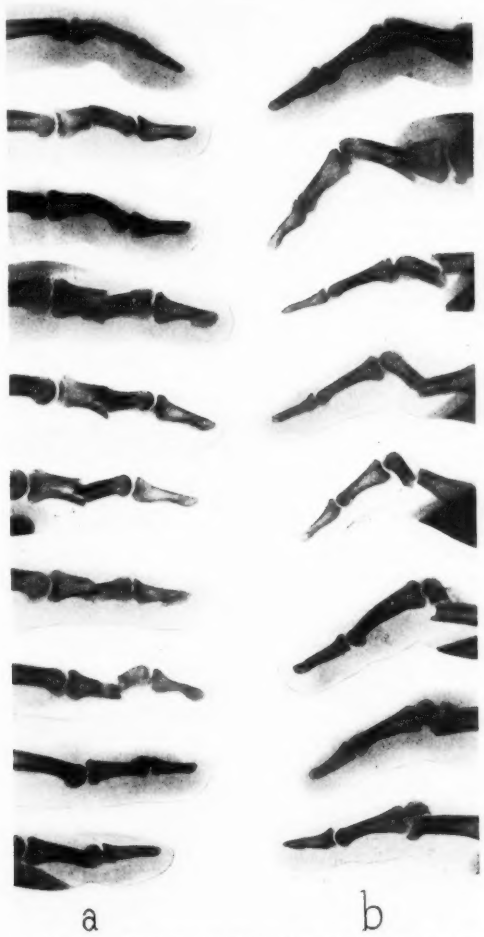

Fig. 3. *a*, Fractures of the middle phalanx at various levels; *b*, fractures of the proximal phalanx at various levels.

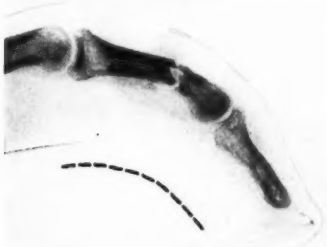

Fig. 5. Restoration of natural arc by the use of a curved splint.

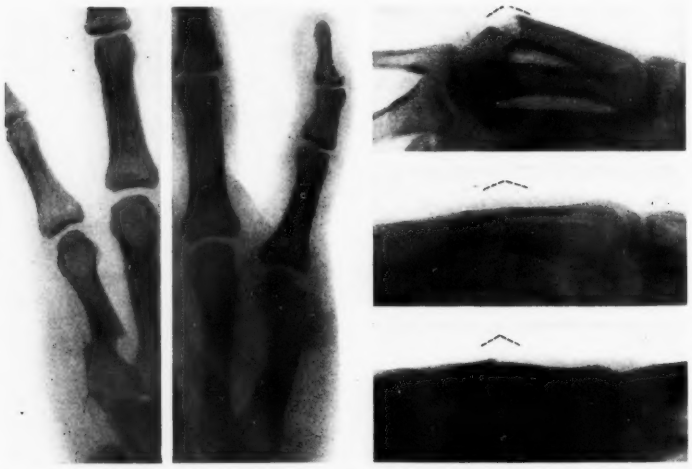

Fig. 6. Fracture of metacarpal bones showing flexed position with dorsal projecting spur.

middle phalanx, at approximately the mid portion. The deformity produced will depend on the location of the fracture site. If this site is distal to the insertion of the tendon, there occurs a downward position of the proximal fragment and upward displacement of the distal fragment. When the fracture site is proximal to the tendon insertion, there is produced downward displacement of the distal fragment with an upward position of the proximal fragment. Examination of the accompanying diagram showing different sites of fracture of the middle phalanx illustrates this point (Fig. 3a).

Failure to take into account these two types of displacement of fragments will result in a failure to correct the deformity. When a straight splint is used for the second type of deformity, there results most commonly a downward projecting spur, which interferes with flexion of the distal phalanx (Fig. 4).

In the second type, adequate fixation can be had by bringing the distal fragment into line by the use of a curved splint, restoring the fragments to the natural arc, which was present before fracture took place (Fig. 5).

Fractures of the proximal phalanx. The resulting deformity when fracture of the proximal phalanx occurs is fairly constant regardless of the site of fracture (Fig. 3b). As can be seen in the accompanying illustration, downward displacement of the proximal fragment is brought about by the action of the interosseus muscle while upward displacement of the distal fragment is due to the action of the lumbrical muscle. Here again fixation on a straight splint will maintain the deformity and result in impaired function. When the distal fragment is brought into line with the proximal fragment by fixation on a curved splint, a minimum of deformity will result.

Fractures of the metacarpals, exclusive of the thumb. Fractures of the metacarpals usually result in typical deformities characterized by shortening of the length of the bone due to bowing of the fragments. There is a dorsal projection at the site of fracture and volar displacement of the metacarpal head (Fig. 6). This configuration is the result of the action of the interosseus muscle which is a flexor of the proximal phalanx. The distal fragment of the metacarpal being attached through the metacarpophalangeal joint to the proximal phalanx assumes a flexed position.

SUMMARY

A summary of the metacarpal and phalangeal deformities with general principles of management may be found in Figure 7. A great amount of detail might be incorporated relative to the management of individual fractures of the metacarpal and phalangeal bones, but the purpose of this paper is to call attention principally to the mechanisms involved in producing the deformities, rather constantly found in these injuries, and also to point out the principles concerned in overcoming these deformities.

In a study of fractured bones, Zuppinger made use of fundamental geometrical principles in explaining and designing the use of various mechanical applications of force to produce correction of

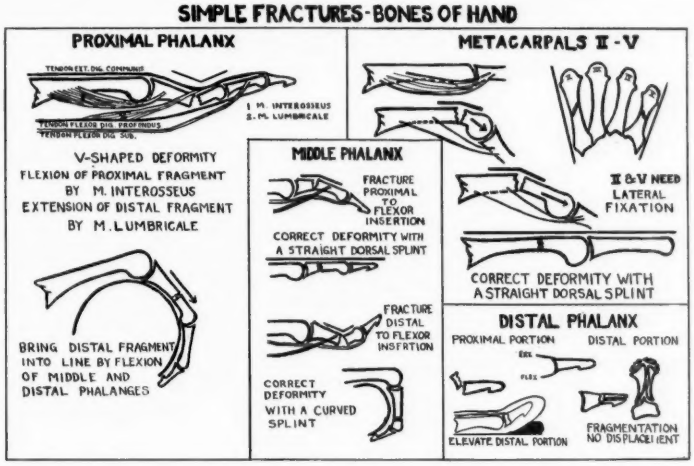

Fig. 7. Illustrating mechanisms of deformities produced by the action of the intrinsic muscles and tendons with suggestions of means for overcoming these deformities.

the deformity. Practical application of Zuppinger's studies is exemplified in the ingenious method of application of a malleable volar splint applied to the finger in extension and firmly secured by adhesive material. The splint is then bent in a curved manner carrying the finger in an arc of palmar flexion. This maneuver increases the length of the dorsal arc thereby producing extension as well as affording a natural curved support for the fractured member.

The management of compound fractures will not be undertaken in this brief discussion because the fundamental principles of management must often be sacrificed because of the concomitant injury to soft parts with impending or present infection.

FRACTURES OF THE JAW

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AN increasing number of fractures of the jaw is being seen at the present time due largely to transportation and industrial accidents. Many of these fractures are necessarily taken care of by dentists and general surgeons. For their consideration a review of the symptoms, treatment, complications, and prognosis of such lesions is presented.

Fractures of the jaws may result from either direct or indirect violence. Dental extractions, surgical removal of impacted molar teeth or of any of the various benign or malignant tumors occurring about the jaws, may be responsible for fractures or they may occur spontaneously secondary to these neoplasms or to osteomyelitis (Figs. 1 and 2). Less commonly the patient's general condition, that is, the presence of rickets or of osteomalacia, may be the underlying factor. The mandible is more frequently fractured than the upper jaw because of its structure and greater vulnerability. A high percentage of fractures of the jaw is compound, usually communicating with the mouth, and many of them are comminuted.

The symptoms and signs are in general those of fracture elsewhere in the body. Local pain, tenderness, loss of function, swelling, hypermobility, crepitus, and ecchymosis are usually present. The most uniform clinical observation, and the most reliable from a diagnostic standpoint, is displacement with accompanying malocclusion of the teeth. This is readily evident on comparing the median line of the lower jaw with that of the upper jaw. It is due to foreshortening of the fractured ramus or condyle and is always to the side of the break. With bilateral fracture of the mandible there is drooping of the anterior segment and the patient is unable to approximate the anterior teeth (Fig. 3). In most cases corroborative roentgenological evidence is relied on in making a positive diagnosis of fracture of the jaw. A negative roentgenogram is at times obtained in cases presenting positive clinical evidence of fracture, due to perfect apposition of the fragments and the superimposition of other bony structures.

Fractures of the jaws bear the possibility of serious complications. These may be the direct result of the trauma responsible for the fracture or they may be due to infection, most commonly from the secretions of the mouth. Of the immediate complications those associated with fracture

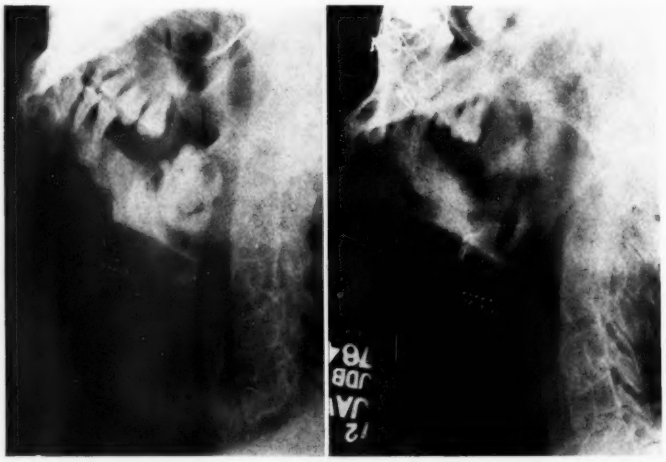

Fig. 1, left. Fracture of mandible resulting from an unsuccessful attempt to remove a solid odontoma, under the mistaken impression that it was an impacted molar tooth.
Fig. 2. Mandible immobilized with interdental wires after the odontoma had been removed. The fracture healed promptly, although non-union had been anticipated.

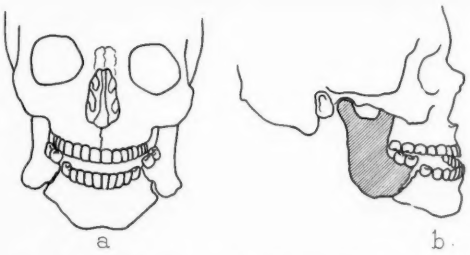

Fig. 3. Sketch made from roentgenogram of bilateral fracture of horizontal ramus of mandible of a man, aged 25 years. Drooping of the anterior segment may be noted.

of the superior maxilla are likely to be more serious than those of the mandible. Fractures of the base of the skull frequently accompany such injuries. The complications of fracture of the mandible include perforation of the glenoid cavity, either through the middle cranial fossa or the external auditory canal, primary or secondary hæmorrhage, and dislocation of one or both condyles. The last condition may readily be overlooked for a time following the fracture due to the false ankylosis resulting from trauma to the muscles of mastication (Figs. 4, 5, and 6). Osteomyelitis and submaxillary or cervical phlegmon frequently develop as a result of mandibular fracture. These complications are more likely to occur with comminution or when a dental root is present in the line of fracture. They can often be prevented by inserting a drain externally down to the line of fracture at the time of fixation, as suggested by Blair and Ivy. Late complications are non-union and bony ankylosis of the temporomaxillary articulation, the possibility of the latter being increased in cases of fracture of the condyle.

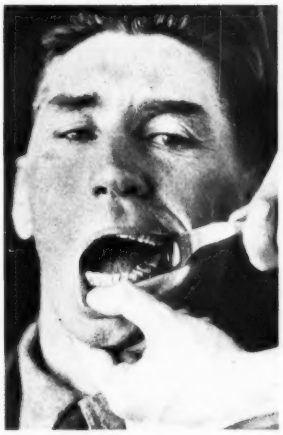

Fig. 4. Wide-open bite due to dislocation of right condyle complicating fracture of the left mandible. The patient came under observation 3½ weeks following treatment of fracture complaining of inability to close his jaws.

Should more serious injury accompany fracture of the jaws or the patient be in shock, these conditions must first receive attention; otherwise immediate reduction and fixation are carried out. In cases coming under observation several days following the injury, so much inflammatory reaction and infection may be present that manipulation for the time being is inadvisable. In this event hot irrigations into the mouth and applications of warm compresses are employed until the process subsides. Not infrequently a phlegmon will develop at this time or later following reduction of

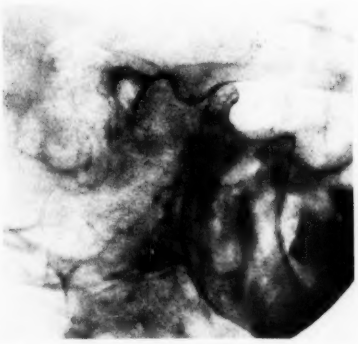

Fig. 5, left. Retouched roentgenogram of anterior dislocation of the right condyle. Same case as shown in Figure 4.

Fig. 6. Retouched roentgenogram of fracture of horizontal ramus of left mandible. Same case as shown in Figures 4 and 5.

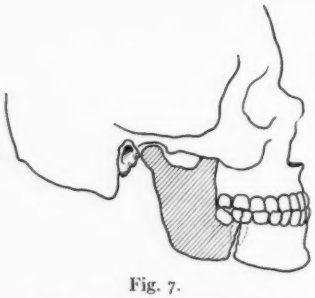

Fig. 7.

Fig. 7. Drawing of roentgenogram of fracture of the mandible with fractured molar tooth. Dental structures in or immediately adjacent to the line of fracture are one of the most common causes of delayed union. Such teeth should be removed at the time of immobilization unless removal is impossible without undue trauma.

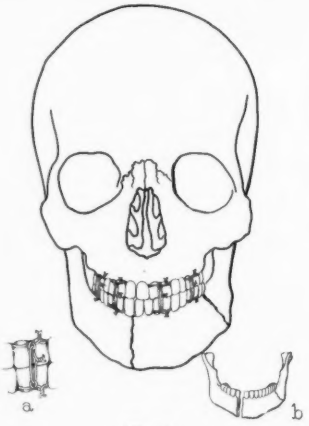

Fig. 8.

Fig. 8. Method of immobilizing fractured mandible by means of interdental wiring. *a*, Ivy's modification of this procedure. An eyelet is made by twisting the middle of the wire prior to inserting the doubled strand between the teeth. The wire completing the loop about the teeth is so placed in relation to this eyelet that traction on the latter tends to tighten the loop. *b*, Fractured mandible before wiring.

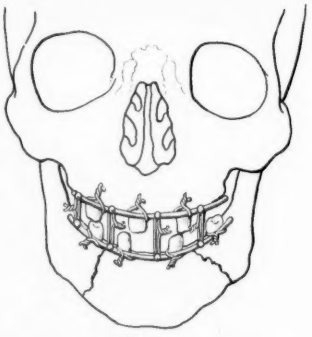

Fig. 9.

Fig. 9. Method of immobilizing fractured mandible when only a few teeth remain in either alveolar process. The pliable metal bars are wired directly to the teeth and rounded knobs on these bars are then united by means of wire loops.

the fracture and require drainage. Bits of detached bone or dental structures in the line of fracture are removed at the time of reducing the fracture, provided they are loosened or can be lifted out without undue trauma (Fig. 7). Lacerations of the oral mucous membrane are packed open with iodoform gauze. External lacerations, however, will produce less scarring, if sutured primarily leaving ample provision for drainage. Depending on the type of injury and external contamination of the wound, the advisability of administering tetanus antitoxin must be given consideration.

The method of immobilization to be utilized in a case of fracture of the jaw is dependent on several factors: the site of the break and its duration, whether single or multiple, the presence or absence of teeth in the fragments, and whether there has been loss of bone. The simplest and at the same time the most universally satisfactory method of immobilizing fractures of the jaws when teeth are present in the fragments is by wiring the upper and lower teeth together (Fig. 8). The teeth in the fractured jaw are thus brought into normal occlusion and the fragments thereby held in correct alignment. As a rule, the application of 10 per cent cocaine solution locally is the only anæsthesia required for this procedure. When there is marked displacement of the fragments or the fracture has existed for a considerable time a general anæsthetic or blocking the second and third

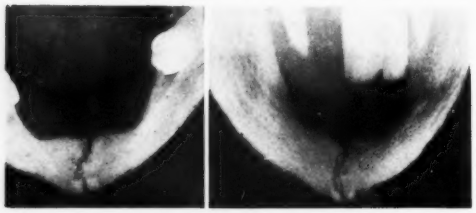

Fig. 10. Spontaneous fracture in the median line of the mandible following electrocoagulation of extensive epithelioma of the lower lip and chin. Satisfactory immobilization of a fracture of this type can, as a rule, be secured by means of a Barton or four-tail bandage.

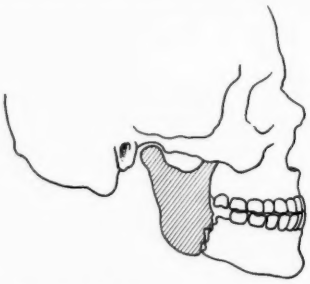

Fig. 11. Drawing of roentgenogram of vertical fracture through the horizontal ramus posterior to the last molar tooth. The edentulous fragment will, as a rule, engage with the end of the anterior fragment and satisfactory immobilization can be secured with intermaxillary wiring.

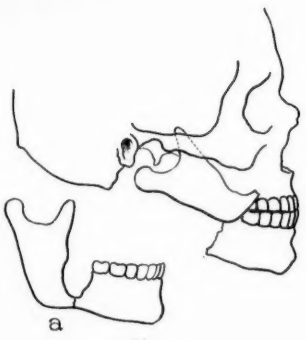

Fig. 12.

Fig. 12. Drawing of roentgenogram of usual displacement of edentulous fragment in cases in which loss of bone is considerable. The posterior fragment is drawn anteriorly and upward against the under surface of the malar bone. At the same time marked lateral and posterior displacement of the anterior fragment occurs. Insert *a* illustrates fracture and extent of loss of bone; in this instance the fracture occurred following the removal of an impacted molar tooth.

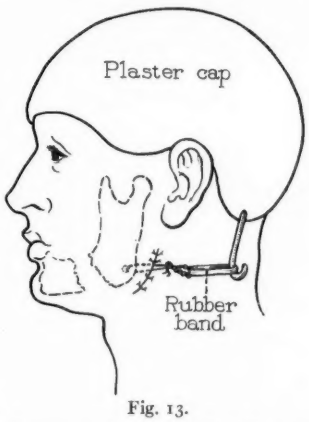

Fig. 13.

Fig. 13. The method used by Ivy and Curtis for correcting displacement of edentulous posterior fragment.

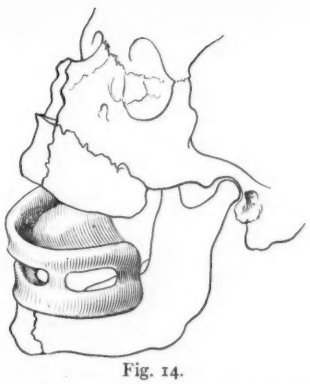

Fig. 14.

Fig. 14. Gunning vulcanite splint for the immobilization of fractures of edentulous jaws. This must be supplemented with a snug head bandage to prevent separation of the jaws. Silver wires passed through the upper alveolar process of the splint and entirely around the mandible are also required in some cases.

divisions of the fifth nerve on one or both sides may be necessary. The latter procedure is usually preferable since with the teeth wired together the vomiting reaction from a general anæsthetic induces a real hazard (Fig. 9). The time necessary to keep the teeth wired together varies in different cases depending on whether the fracture has been seen immediately or several weeks after its occurrence. The age and general condition of the patient, the severity of the inflammatory reaction present in the soft tissues, and the presence of osteomyelitis or osteitis at the site of fracture are likewise factors in this regard. From 3 to 4 weeks in children to approximately 6 weeks in healthy adults is the usual time unless there is considerable local infection. Under favorable circumstances firm healing of mandibular fractures will often take place in patients of advanced years in less than 6 weeks.

The various head bandages, including the Barton and the four-tail, are of little value in the fixation of mandibular fractures, except in supplementing other measures. They should not be used alone except in median line fractures without displacement as they exert posterior as well as upward pressure and they accordingly tend to

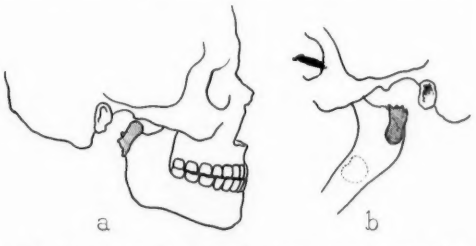

Fig. 15. Drawings of roentgenograms of fractures of the condyle. *a*, Fracture of this type in a girl aged 16 years. Although no attempt was made to replace the condyle in the glenoid cavity the result was excellent, both from a cosmetic and functional standpoint. The mandible was immobilized for 5 weeks by wiring the upper and lower teeth together. *b*, Fracture of condyle of a boy aged 8 years. Treatment consisted of immobilization of the mandible for a period of 3 weeks. Although the functional result was good the jaw was displaced slightly to the side of the fracture on opening the mouth widely.

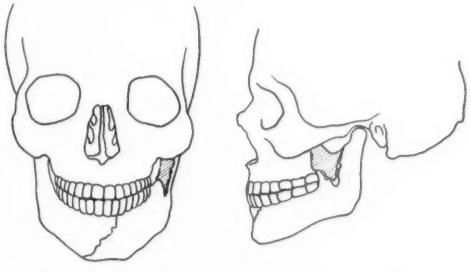

Fig. 16. Drawing of roentgenogram of fracture of left coronoid process and across the symphysis of the mandible resulting from a blow on the chin of a man aged 72 years.

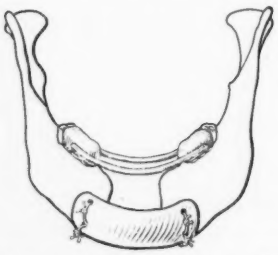

Fig. 17. Bone graft for fracture of mandible with considerable loss of bone. Graft is held in place by means of chromic catgut ligatures. The dental appliance for immobilizing the fragments may be noted.

Fig. 18, left. Loss of posterior two-thirds of the right mandible and paralysis of the right seventh nerve, the result of a mining accident. Displacement of lower jaw on opening mouth may be noted.

Fig. 21. Following the use of bone graft (compare with Figure 17). The displacement of the lower jaw on opening the mouth has been overcome.

produce overriding of the fragments with increased deformity (Fig. 10).

Fractures of the mandible in which no teeth remain in the posterior fragment are often difficult to immobilize on account of the tendency for the muscles of mastication to displace the edentulous fragment. When the plane of the fracture is approximately vertical the edentulous fragment will often impinge on the posterior end of the anterior fragment (Fig. 11). If the fracture extends downward and posteriorly through the angle or transversely across the ascending ramus, or if there is appreciable loss of bone, the posterior fragment will as a rule slip forward and be drawn upward into the mouth (Fig. 12). Reduction and immobilization of such a fracture often requires considerable ingenuity. One of numerous dental appliances designed to make pressure against the posterior fragment inside the mouth may be used, a nail may be driven through the coronoid process or the procedure recently described by Ivy and Curtis (3) may be resorted to (Fig. 13).

Fractures of edentulous jaws are best treated with vulcanite intermaxillary splints. Such splints consist of a double bite block into which the upper and lower alveolar processes fit snugly (Fig. 14). Fractures of the jaws do not lend themselves well to fixation with metal plates on account of the proximity of the infected oral cavity and the stress placed on them. Little is likely to be accomplished by attempting their use either in

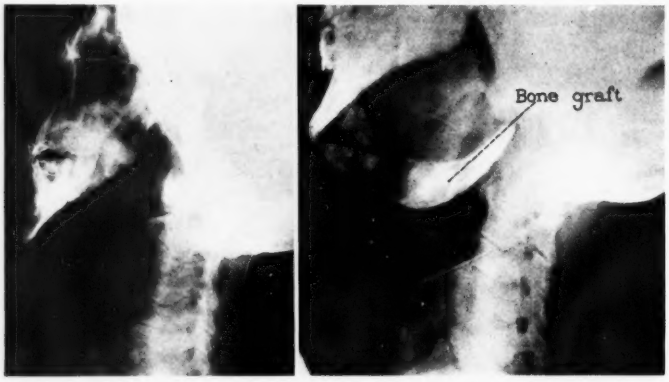

Fig. 19, left. Retouched roentgenogram which shows the loss of the posterior portion of the right mandible in case illustrated in Figure 18.

Fig. 20. Roentgenogram following use of bone graft from the iliac crest. Same case as shown in Figures 18 and 19. It may be noted that the superior end of this is articulated in the glenoid cavity.

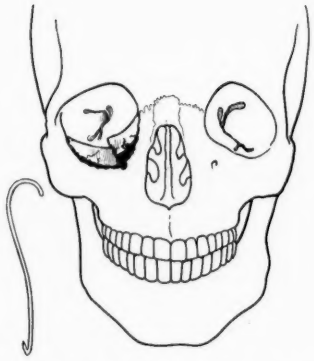

Fig. 22. Drawing of roentgenogram of fracture of the lower orbital border with displacement posteriorly. Such fractures usually extend into the infra-orbital foramen and canal resulting in injury to the infra-orbital nerve. The malar bone also is commonly involved and accompanying this there frequently is displacement inferiorly of the orbital floor resulting in diplopia. Insert shows steel wire hook used in elevating fractures of this type.

Fig. 23, left. Traumatic scarring and depressed fracture of the inferior orbital border and malar bone, due to an automobile accident 3½ months previously.

Fig. 24. Result following excision of scars and insertion of cartilage implant to restore the orbital border and malar prominence.

this group or in the preceding groups of cases. They should never be used until complete healing of the wounds in the soft tissues has taken place.

Fractures of the condyle are best demonstrated in roentgenograms of the mastoid area and in those taken in the so called Towne position, that is obliquely from above and anteriorly with the patient lying on his back. Such fractures have at times been subjected to open operation. The results have not been very satisfactory because of the difficulty of maintaining alignment. Also the operation involves considerable hazard as regards the possibility of injury to the facial nerve. A number of such patients treated in The Mayo Clinic by fixation with interdental wiring has obtained excellent results even when marked displacement of the condyle was present (Fig. 15). In no instance was any attempt made at replacement of the condyle in the glenoid fossa, yet a normally functioning jaw with little, if any, displacement or deformity resulted. Scudder, on the contrary, stated that fractures of the condyles generally result in ankylosis.

Fractures of the coronoid process are unusual. When unaccompanied by fracture of other portions of the mandible immobilization for a week or two only is required (Fig. 16).

Repair of fractures of the jaw is always greatly delayed with loss of an appreciable amount of bone. Non-union is the rule and bone graft after complete healing of the wound is required. While healing is taking place fixation of the fragments is secured by means of one of the mechanical appliances mentioned, or preferably, if a sufficient number of teeth is present, by interdental wiring. If the wound in the mouth is permitted to heal without such fixation, the fragments will be drawn together by the scarring and marked deformity will result. It then becomes necessary to free the scarring sufficiently to permit of restoring the fragments to their normal position where they are held firmly until healing is complete, when a bone graft may be inserted.

Non-union of fractures of the mandible may be due to loss of bone, unsatisfactory immobilization, improper apposition of the fragments, osteomyelitis, syphilis, or the presence of a dental root or sequestrum in the line of fracture. Treatment depends on the cause of non-union. When due to loss of bone, it is invariably permanent without the use of a bone graft. Non-union due to any of the other causes will, in most cases, be overcome and firm union will take place on directing proper treatment to the causative factors. Dental structures or sequestrum in or adjacent to the fracture are commonly responsible for lack of union. Even though the condition is of several months standing removal of the offending objects will usually be followed by prompt healing. Osteomyelitis aside from free drainage should be treated conservatively. Syphilis may be a factor in this condition, in which event antisyphilitic measures should be instituted. In a case of non-union encountered recently syphilis was present, and a metal plate used in a futile attempt to immobilize the fragments was acting as a foreign body. The secondary pyogenic infection persisted until the plate

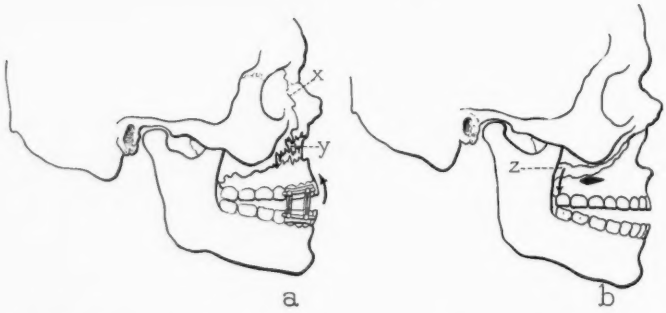

Fig. 25. *a*, Drawing made from roentgenogram of comminuted fracture, *y*, of the superior maxilla of a girl, aged 18 years, the result of an automobile accident. The anterior portion of the superior alveolar process and bony palate was displaced upward about a fulcrum situated posteriorly just above the tuberosity. In addition, the fracture extended upward, *x*, mobilizing a large portion of the face and involving the cribriform plate. Dental caps with elastic bands utilized in drawing the upper alveolus down into occlusion after the patient had recovered from the immediate effects of the skull fracture are shown. *b*, Drawing of roentgenogram of fracture, *z*, of superior maxilla the result of an accident. The patient, a boy aged 15 years, ran into a clothesline with his mouth open. The line engaged behind the upper molar teeth and the fracture occurred on the rebound, resulting in downward displacement of the posterior portion of the alveolar process together with most of the remainder of the superior maxilla about a fulcrum situated high up anteriorly. Treatment consisted of wiring the upper and lower teeth together and applying a snug head bandage. An excellent result was obtained.

was removed, in spite of treatment for the syphilis. Non-union due to unsatisfactory immobilization demands further mechanical consideration. Fixation may be extremely difficult, if not impossible, if patients do not co-operate.

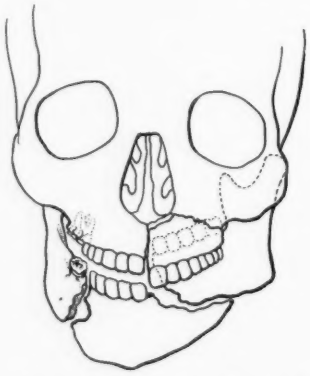

Fig. 26. Drawing of roentgenogram of multiple fractures of the upper and lower jaws, and dislocation anteriorly of the one condyle, the result of an automobile accident. This patient came under observation a week after the injury and there was marked infection and acute inflammatory reaction present, necessitating delay of a week longer to manipulate and immobilize the fragments.

In cases of persistent non-union, bone grafting is indicated. Prior to undertaking this it is essential that the wound inside the mouth as well as that externally should be completely healed, and that any teeth near the ends of the fragments should be extracted, and that ample time should be given for the sockets to become obliterated. Some means must also be arranged to insure firm fixation of the fragments (Fig. 17). Any of the various types of bone transplants may be utilized. A massive bone graft from the crest of the ilium is,

Fig. 27. Roentgenogram following immobilization of fractures (Fig. 26). A single metal arch was wired to the teeth in the normal remnant of the superior alveolar process and the remaining fragments were then drawn into position by wiring to this. The two upper molars which were driven into the antrum were removed. Open reduction of the dislocated condyle was necessary.

as a rule, most satisfactory. Grafts may also be obtained from a rib or the tibia, or bone from the lower border of one fragment of jaw may be slid across to bridge the defect. The graft is introduced through an external incision below the border of the mandible. Following this the jaw should be fixed for at least 2 months, depending on the roentgenographic appearance of the graft (Figs. 18, 19, 20, and 21).

Malunion of fracture of the jaw sufficiently pronounced to require surgical treatment is unusual. Serious consideration should be given the possibility of correcting the deformity and the interference with function due to it by prosthesis or otherwise before resorting to refracture, because of the possibility of infection and of non-union.

Fractures of the upper jaw are usually the result of crushing blows to the face. Automobile accidents account for a high proportion of such injuries. They are often more difficult to reduce and immobilize satisfactorily than are mandibular fractures, and permanent facial deformities commonly result. Such deformities are by no means an indication of lack of skillful treatment at the time of injury in all of these cases. Many such injuries are extremely serious, a high percentage being accompanied by fracture of the skull, so that manipulation of the bony fragments is often not advisable during the first 2 weeks. By the end of that time sufficient fibrous union will often have taken place greatly to increase the difficulty of properly aligning the fragments, if not to render this quite impossible without excessive trauma. Correction of the deformity can, therefore, be carried out more satisfactorily after complete healing has taken place.

When fractures are limited to the superior maxilla they most commonly involve the alveolar process and the inferior orbital border. Fractures of the alveolus may be limited to a small portion of the process bearing one or several teeth. They may, on the other hand, involve the entire alveolus on one or both sides, so that this, together with the corresponding portion of the bony palate is completely mobilized, being supported only by the soft tissues attached to it. The teeth or any portion of the alveolus may be driven upward and impacted within the antrum or the nasal fossa.

In fractures of the lower orbital border the bony ridge is usually forced posteriorly into the orbit or inferiorly into the antrum (Fig. 22). Injury to the infra-orbital nerve with anæsthesia of the area supplied by it is usually present in these cases. Depression or flattening of the upper portion of the cheek also results, especially in those cases with fracture of the malar bone as well. Œdema usually conceals the deformity of the cheek for a considerable time following the injury, and palpation and roentgenographic examination alone will reveal the change. When recognized within a few days after the injury, depressed fractures of the orbital border can usually be elevated readily. This may be accomplished by grasping the depressed bone with a heavy towel clamp directly through the skin and manipulating it into position (2). The screwporte may be used for the purpose as suggested by Ivy and Curtis (4). A periosteal or septal elevator inserted through a small incision lateral to the outer orbital margin may be used as a pry or a metal sound introduced into the antrum through a naso-antral window as suggested by Shea may be employed particularly in those cases with depressed fracture of the anterior wall of the antrum. A heavy metal probe carried through the canine fossa may accomplish the same objective (Lothrop). A rigid steel wire hook introduced through a small incision over the fracture has proved satisfactory in most of the cases treated in The Mayo Clinic (Fig. 22). The hook is carried posteriorly onto the floor of the orbit just far enough to permit its sharp edge to engage the overhanging bony edge of the orbital border. With traction on the hook the depressed bone is then drawn up into its normal position. At times there is a distinct clicking or snapping sound as the bone buckles out into normal alignment and only moderate traction is required. More frequently no sound is heard and considerable force must be exerted. Usually there is no tendency for the deformity to recur. At times, however, the bone sags back immediately on releasing the pull and it is necessary to maintain this for several days. For the purpose a properly shaped stiff wire arch is utilized, this being strapped to the face in such a manner that its looped ends rest on the bone at a considerable distance from the fracture. The hook supporting the fracture is fastened to this rigid arch. When the presence of such a fracture is not recognized for 2 or 3 weeks following the injury, so much fibrosis will usually have developed that elevation of the fracture as described is extremely difficult or quite impossible, and it is better to wait until complete healing has taken place and then insert a bone or cartilage implant for correction of the deformity. Costal cartilage serves the purpose most satisfactorily. The implant is shaped according to a model prepared from dental compound. Sufficient perichondrium is left on its anterior surface to permit it to be sutured in place (Figs. 23, 24).

Fractures involving only a portion of the superior alveolar process may be immobilized satis-

factorily by wiring the upper and lower teeth together when one or more teeth remain in the normal remnant of the superior alveolus. If teeth are present at both sides of the fracture a dental appliance can be used to advantage. Fractures in which there is complete separation of the alveolar process and hard palate from their bony attachment above may likewise be fixed by intermaxillary wiring in some cases, but this must be supplemented by a snug bandage in order to prevent movement of the mandible. When there is comminution of the maxillæ above the palate, in such cases fixation from the skull is necessary. This requires the application of a plaster-of-Paris skull cap in which are incorporated two adjustable metal arms for the support of a dental appliance. Non-union of such fractures may occur and a difficult problem is then presented, since the thinness of the bone and the inaccessibility to surgical approach through a sterile field greatly lessen the chances of successfully transplanting bone. In fractures of the upper jaw accompanied by fracture of the cribriform plate or of the base of the skull further posteriorly, the patient may be in such precarious condition that any manipulation is inadvisable for at least a week or two following injury. There may be in addition upward displacement and impaction of the parts (Fig. 25).

Multiple fractures of the upper and lower jaw in which there is mobilization of both entire alveolar processes are at times encountered. Fixation in such a case often necessitates the use of a dental appliance consisting of a double bite block rigidly supported by adjustable metal arms attached to a plaster-of-Paris skull cap. Even a small portion of the superior alveolar process remaining intact in such a case is of great help in securing immobilization, as it supplies a fixed point that otherwise must be furnished by mechanical means. At times in a case of the latter type satisfactory fixation can be secured by the use of a single rigid metal arch. This is wired to the teeth in the normal superior alveolar remnant, and the teeth in the several fragments are drawn into occlusion by wiring to it (Figs. 26 and 27).

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VAGINAL VERSUS RECTAL EXAMINATIONS IN RELATION TO OBSTETRICAL MORBIDITY FOLLOWING THE MERCUROCHROME TECHNIQUE

An Analysis of 3,884 Cases at the Methodist Episcopal Hospital in Brooklyn, New York[1]

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SINCE obstetrics has become recognized as a science, many efforts have been made to reduce maternal morbidity and mortality. Reis and Kronig in 1893 recommended the use of rectal examinations. There have been many arguments for and against this procedure; and, today, rectal examinations are not universally accepted as the proper method in following the course of labor. They were first introduced in order that the prevalence of puerperal sepsis might be lowered; but, after almost 30 years, there seems to be no decrease in this disease. If we have lowered the number of deaths from sepsis by rectal examination, we have introduced some other factor which has acted as a counterbalance.

Fourteen years ago Moore stated that "Rectal examination alone, or when combined with abdominal palpation in pregnancy and labor, as a substitute for vaginal examination during parturition, is not compatible with an intelligent management of childbirth." He advised a primary vaginal examination in all cases first seen in labor, and of course, where any operative interference is indicated.

De Lee states that "one can overdo rectal exploration. It is not needful to make many as the progress can be measured by abdominal examinations and intelligent observation of the processes of nature. Too many rectals may injure the delicate mucosa and rough manipulations should be avoided. The thin edematous septum may possibly be punctured."

When the patient complains that the rectum is sore, Campbell believes that there is no question about there having been too many rectal examinations. Thrombosis may be encouraged in an external hæmorrhoid, which otherwise might escape. A rectal examination is never pleasant, and it is doubly distasteful at a time when, through instinct, the patient would rather not be disturbed. He mentions the case of a patient operated on for ischiorectal abscess, who dated her trouble from a confinement 6 months previous. "With a history of protrusion or bleeding following stool, whether from hæmorrhoids or prolapsed mucous membrane, rectal examinations should be as few as possible. If there is pain or sphincteric spasm, they are contra-indicated except for diagnosis of a rectal condition. There is a physiological magnification of rectal pathology during pregnancy. The rectal tissues share to a certain extent in the congestion and softening incident to pregnancy, and obstruction from the weight of the gravid uterus increases any tendency to varicosity of the hæmorrhoidal veins. Bleeding indicates a break in the mucous membrane and a little added trauma may force bacteria below the surface at this point. A low grade infection may be set up which will cause the hæmorrhoidal condition to become so progressive as to require operation at a future time."

Parke stated that the tyro learns nothing from rectal examinations, and it is difficult to convince the beginner that it is worth while to practice the method often enough to acquire confidence in his findings, for a large experience is required to learn the finer points. He believes that in 90 per cent or more of the cases, one can get all the information that is needed in the conduct of labor.

Coldren, writing from the standpoint of the student, states that it is not easy to feel things in the vagina with a finger in the bowel. He states that the student struggles through his course of instruction pretty much in the dark about the parturient vagina, but as soon as he gets out into practice, away from the watchful eye of the instructor, he begins to feel the need of knowing something about the patient beyond the fact that she seems to be pregnant, and he proceeds to learn his obstetrics at first hand, as occasion demands.

The medical schools have been teaching the use of rectal examinations for many years. The course offered in obstetrics is very meager, and the opportunities are few for the students to learn the art of rectal examination. When we realize how difficult it is for even an experienced obstetrician to be convinced of his rectal findings, that an error of 10 per cent is generally admitted (and with the inexperienced it must be higher), how can we expect the neophyte to make no serious mistakes. Five thousand medical students are licensed every year, and it is required of them that

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TABLE I.—RECTAL AND VAGINAL EXAMINATIONS, WARD CASES
Exclusive of Cæsarean Sections—1929–1930

	Spontaneous			Operative			Total cases		
	Cases	Morbidity	Per cent morbidity	Cases	Morbidity	Per cent morbidity	Cases	Morbidity	Per cent morbidity
Rectals only	545	27	4.7	166	8	4.8	711	35	4.9
Rectals plus one vaginal	64	2	3.1	73	9	12.3	137	11	8.02
Rectals plus two or more vaginals	19	1	5.2	25	2	8.0	44	3	6.8
Vaginals only	309	22	7.1	107	9	8.4	416	31	7.4
Vaginals plus one rectal	200	14	7.0	91	4	4.3	291	18	6.1
Vaginals plus two or more rectals	41	2	4.8	27	5	18.5	68	7	10.2
No examination	52	3	5.7	8	1	12.5	60	4	6.6
Total	1230	71	5.7	497	38	7.6	1727	109	6.3

they deliver a certain number of obstetrical patients. Some medical colleges insist that they spend 1 year in a hospital with maternity service. Thus, it is reasonable to make the assertion that before a man is sure of his rectal findings, he must follow at least one hundred patients through labor. If this is true, when we consider how our hospitals are manned almost entirely by internes (many of whom are not interested in and will not practice obstetrics) and realize that they are entrusted with the lives and offspring of our best citizens, it behooves us to reduce the number of their mistakes to a minimum.

Patients enter our best maternity hospitals, take the best rooms, pay for one or two private nurses to care for them, and often their entire labor is under the supervision of an inexperienced interne who follows the course of labor by means of rectal examinations. He is really a student, learning the art of rectal examinations. Then when the patient is about ready for delivery, or perhaps after she has labored all night, with an unrecognized disproportion, or a concealed second stage of labor, the attending obstetrician appears on the scene, and proceeds to complete, perhaps, a long delayed delivery.

If students do only rectal examinations, it is difficult for them to interpret their findings. However, if each rectal examination were immediately checked by someone of experience, or if it were followed immediately by a vaginal examination, we might conceive of an excuse for this practice without endangering the life of the unborn child. How many mistakes are made annually and the number of infants who are lost because of a prolapsed cord or because of a concealed second stage of labor, will never be known.

I often wonder if there is really any difference between the use of vaginal and rectal examinations as far as infection is concerned. During the rectal examination, the posterior vaginal wall is forced into the cervix and many times this belongs to the lower third of the vagina, which is not considered sterile. Rectal examinations are usually cervical examinations; while during vaginal examinations it is only necessary to outline the cervix. When the rectal examination is completed, the pelvic floor is contaminated, unsterile gloves are frequently used, the doctor is prone to be careless, the thumb may enter the vagina, and the doctor, even though experienced in rectal examinations, is often left in doubt. The glove, the posterior vaginal wall, which may be œdematous, and the high position of the presenting part, may render it difficult or impossible to make a satisfactory examination.

Before making a vaginal examination, the patients are usually more carefully prepared, and the perineum is kept cleaner during labor. The patient is more pleased with the examination, and the satisfaction of knowing and not guessing the condition of the cervix, etc., is of no little moment.

When the rectal examinations were first introduced, vaginal antisepsis was not used. Today it is practically possible to sterilize the vagina, and repeated vaginal examinations can be done with little, if any, added risk to the mother. Our students and internes can be taught more and better obstetrics, and is it not possible that maternal and fetal mortality and morbidity may be reduced?

La Vake believed that the greatest potential danger resident in rectal examination is overlooking what has been called "the concealed second stage of labor." The patient may be allowed to continue in labor without a vaginal check being made, because the physician believes that she is in the first stage of labor, when she is really in the

TABLE II.—RECTAL AND VAGINAL EXAMINATIONS, PRIVATE CASES
Exclusive of Cæsarean Sections—1929–1930

	Spontaneous			Operative			Total cases		
	Cases	Morbidity	Per cent morbidity	Cases	Morbidity	Per cent morbidity	Cases	Morbidity	Per cent morbidity
Rectals only	622	28	4.5	614	36	5.8	1236	64	5.1
Rectals plus one vaginal	84	3	3.5	161	7	4.3	245	10	4.4
Rectals plus two or more vaginals	28	3	10.7	79	6	7.5	107	9	8.4
Vaginals only	78	2	2.5	101	8	7.9	179	10	5.5
Vaginals plus one rectal	40	4	10.0	59	2	3.3	99	6	6.06
Vaginals plus two or more rectals	83	3	3.6	159	8	5.03	242	11	4.5
No examination	39	4	10.2	10	1	10.0	49	5	10.2
Total	974	47	4.8	1183	68	5.7	2157	115	5.3

second stage of labor. One may not find out his mistake until untoward signs on the part of the mother and child demand interference.

The literature was carefully reviewed by La Vake in 1928, and he found very few comparative statistics concerning rectal and vaginal examinations. Among the most important contributors were:

Jegge who compared 500 cases examined vaginally with 500 examined rectally. The morbidity of the former was 11 per cent, and of the latter, 6 per cent.

Guggisberg reported 4,642 cases examined vaginally, with a morbidity of 17.5 per cent; 11.2 per cent of which developed genital infection; and 0.12 per cent died from sepsis; while 3,010 cases examined rectally showed only 11 per cent morbidity; 5.5 per cent of which showed genital infections; and there were no deaths from sepsis.

Reis stated that of 609 patients examined vaginally, 47 per cent were afebrile; of 271 examined rectally, 46 per cent were afebrile; while of 106 not examined at all internally, 57 per cent were afebrile. He concludes: "If then, as most workers agree, the rectal examination is only 90 per cent efficient for diagnosis, and if it is especially inadequate for abnormal and pathological cases, it would seem that at least one vaginal examination is desirable early in every case of labor. . . . The rapidity and ease with which the rectal examination can be made recommends it strongly, but it does not seem that rectal examination should replace the vaginal examination in a well conducted maternity hospital where vaginal examination can be made under aseptic precautions."

Dean, in 1925, stated that rectal examinations were used by a very small minority of the profession in following the progress of labor. He stated that in placenta prævia or unusual bleeding cases, in obese primiparæ, and in cases with an abnormal presentation, when it was difficult or impossible to reach the cervix, a vaginal examination should be made, although he favored the use of rectal examinations.

Welz says: "Rectal examinations are objectionable because they are not always accurate, they increase the danger of infection, and may result in injury to the rectum."

In previous articles I have endeavored to study the effect of vaginal antisepsis on cæsarean sections, bag inductions, and maternal morbidity and mortality. The following is the result of a study carried on at the Methodist Episcopal Hospital during the 2 years, 1929 and 1930.

In this hospital, we have two services: the first is in charge of Dr. O. P. Humpstone; the second is in charge of Dr. R. M. Beach. Beginning January 1, 1928, we endeavored to make it the routine practice for the second service that the ward patients should be examined only vaginally; and for the first service, only by rectum. If we could have made the rule inviolable, the results would have been much better. When a patient was admitted in active labor, it was often important to examine her before she was prepared. Therefore, on the second service, we permitted the internes to make a single rectal examination in these cases; but after the patient was prepared and instilled, only vaginal examinations were in order. On the first service there were to be no vaginal examinations, but needless to say, there were times when a vaginal examination was indicated. This upset the routine, and it is, therefore, difficult to draw proper conclusions. Almost every case with a prolonged labor, or any other abnormality, as to the presentation, position, etc., had a vaginal examination. Thus it is easy to see that every case

TABLE III.—RECTAL AND VAGINAL EXAMINATIONS, TOTAL CASES
Exclusive of Cæsarean Sections—1929–1930

	Spontaneous			Operative			Total cases		
	Cases	Morbidity	Per cent morbidity	Cases	Morbidity	Per cent morbidity	Cases	Morbidity	Per cent morbidity
Rectals only	1167	55	4.7	780	44	5.6	1947	99	5.08
Rectals plus one vaginal	148	5	3.3	234	16	6.8	382	21	5.4
Rectals plus two or more vaginals	47	4	8.5	104	8	7.6	151	12	7.9
Vaginals only	387	24	6.2	208	17	8.1	595	41	6.8
Vaginals plus one rectal	240	18	7.5	150	6	4.0	390	24	6.1
Vaginals plus two or more rectals	124	5	4.03	186	13	6.9	310	18	5.8
No examination	91	7	7.6	18	2	11.1	109	9	8.2
Total	2204	118	5.3	1680	106	6.3	3884	224	5.7

with a difficult delivery or prolonged labor is classed under those cases having vaginal examinations.

A vaginal examination should be very little more than the procedure of instillation with mercurochrome. The barrel of the syringe is as large as the two fingers and it could carry the bacterial flora to the cervix. Thus we might say that every patient had the equivalent to a vaginal examination.

We have considered only those examinations done before the time of delivery. When the patients are prepared and ready for delivery, we make no effort to keep out of the vagina. Many cases had vaginal examinations at this time. Many were forceps cases. In many, episiotomies were indicated or lacerations ensued. The perineum is very often ironed out manually. These factors offer many opportunities for transfer of bacteria from the lower to the upper part of the vagina.

ANALYSIS OF MORBIDITY

The uncorrected morbidity on the first obstetrical service for the 2 years was 6.9 per cent, and on the second, 7.3 per cent. If we omit the cæsarean sections, the morbidity was 5.1 per cent for the first obstetrical service, and 6.5 per cent for the second; while the corrected morbidity was 3.4 per cent for the first and 2.2 per cent for the second. The following tables analyze the morbidity, not according to service but according to the method by which the labor was followed, either by rectal or vaginal examinations. Any case in which the patient had a temperature of 100.4 degrees F. on two consecutive days, not including the day of delivery, and occurring on or before the tenth day, is considered a morbidity.

Table I shows the comparative morbidity for the spontaneous and operative cases following the use of rectal and vaginal examinations on the ward service. There were delivered 1,727 cases with a morbidity of 6.3 per cent; 1,230 of these were spontaneous, with a morbidity of 5.7 per cent; and 497 were operative with a morbidity of 7.6 per cent. It is rather interesting to note that there was but 0.1 per cent difference between the operative and spontaneous cases which had rectal examinations only; while 200 cases which were followed by vaginal examinations and had only one rectal, had a morbidity of 7 per cent for the spontaneous, and 4.3 per cent for the operative. The question might be asked: "Why did the operative have less morbidity than the spontaneous?" Rectal examinations were made in 540 cases with one or more vaginals and the morbidity was 7.2 per cent, while 956 cases had at least one vaginal examination with a morbidity of 7.3 per cent. Sixty cases were delivered without being examined during labor, with a resulting morbidity of 6.6 per cent.

In Table II, 2,157 private cases with a morbidity of 5.3 per cent have been analyzed. The operative morbidity is but 0.9 per cent greater than the spontaneous, while the majority of the cases, 1,236, were followed by rectal examinations with a morbidity of 5.1 per cent. Six hundred and ninety-three additional cases had at least one rectal examination and one or more vaginal examinations with the same morbidity, 5.1 per cent. The added vaginal examinations did not increase the morbidity. At least one vaginal examination was made in 872 cases with a morbidity of 46 or 5.2 per cent. Forty cases in this table had no examination whatever with a morbidity of 10.2 per cent.

Table III combines the ward and private patients and analyzes 3,884 cases with a morbidity of 5.7 per cent. Of the 3,884 cases, 2,204 were spontaneous with a morbidity of 5.3 per cent, and

TABLE IV.—RECTAL AND VAGINAL EXAMINATIONS, CÆSAREAN SECTIONS
With and Without Morbidity—1929–1930

	Without morbidity	With morbidity	Total	Per cent morbidity
Rectals only	21	24	45	53.3
Rectals plus one vaginal	4	3	7	42.8
Rectals plus two or more vaginals	4	2	6	33.3
Vaginals only	4	8	12	66.6
Vaginals plus one rectal	4	5	9	55.5
Vaginals plus two or more rectals	7	5	12	41.6
No examination	24	21	45	46.6
Total	68	68	136	49.6

1,680 were operative, with a morbidity of 6.3 per cent. One thousand nine hundred and forty-seven were followed by rectal examinations only, with a morbidity of 5.08 per cent. One thousand two hundred and thirty-three cases had both vaginal and rectal examinations with a morbidity of 6.08 per cent. Ten thousand eight hundred and thirty-two rectal examinations were made on 3,180 cases, or an average of 3.4 to the patient. Five hundred and ninety-five cases were followed by vaginal examinations alone, with a morbidity of 6.8 per cent. There were 390 additional cases which were followed by vaginal examinations but had a single rectal examination on admission, making a total of 985 with a morbidity of 6.5 per cent. One thousand eight hundred and twenty-eight had at least one vaginal examination with a morbidity of 6.3 per cent. This gives a morbidity for the cases followed by vaginal examinations of 1.3 per cent greater than those followed by rectal examinations only. There were 4,811 vaginal examinations among 1,818 patients, or an average of 2.6 to the patient. We must realize that the rectal group does not include the more difficult cases. Two thousand four hundred and eighty cases were followed by rectal examinations, with a morbidity of 5.3 per cent, 533 of which had at least one vaginal examination. There were 109 cases not examined during labor, with a morbidity of 8.2 per cent.

Table IV analyzes the morbidity of 136 cases following cæsarean section, with a morbidity of 49.6 per cent, 45 of which were followed by rectal examinations with a morbidity of 53.3 per cent. There were 58 cases which had at least one rectal examination with a morbidity of 50 per cent. Forty-six cases had at least one vaginal examination with a morbidity of 50 per cent. Forty-five cases were not examined during labor, with a morbidity of 46.6 per cent. This group includes the majority of cases of elective cæsarean sections, without a test of labor.

Maternal mortality. There were no maternal deaths from sepsis in the 3,884 viable vaginal deliveries, and only one death from sepsis in 136 cæsarean sections. This patient had ruptured membranes for 5 days before operation.

Personal cases. There were 238 of 281 personal private cases which had at least one vaginal examination, with a morbidity of 14 or 4.9 per cent. Thirty-six patients had only rectal examinations, with a morbidity of 4.7 per cent, and seven were not examined and were without morbidity.

SUMMARY

A review of the literature emphasizes the inaccuracy of rectal examinations.

Rectal examinations, although accepted as a routine procedure in a large number of hospitals, are not universally accepted (indeed they are sometimes condemned).

Many mistakes are undoubtedly made by those who are learning the art of rectal examinations, while a 10 per cent error is admitted for those of experience.

Vaginal examinations are much more satisfactory to both the patient and the physician, and the satisfaction of knowing, and not guessing, the condition of the cervix is of great value.

Rectal examinations may injure the recto-vaginal septum and aggravate pathological conditions; such as, hæmorrhoids, fissures, etc.

Following viable vaginal deliveries, 3,884 cases had an uncorrected morbidity of 5.7 per cent. The difference between the operative and the spontaneous morbidity was 1 per cent.

A comparative study of the ward and private cases showed 1 per cent less morbidity for the private cases, while the cases followed by rectal examinations had less morbidity only on the ward services.

In 1,947 cases with only rectal examinations there was a morbidity of 5.08 per cent; and in

3,180 cases that had at least one rectal examination the morbidity was 5.4 per cent.

Ten thousand eight hundred and thirty-two rectal examinations were done on 3,180 patients, or an average of 3.4 to the patient.

In 595 cases in which only vaginal examinations were made the morbidity was 6.8 per cent; while in 985 cases, 380 of which had had a single rectal examination before being prepared, the morbidity was 6.5 per cent.

One thousand eight hundred and twenty-eight cases had 4,811 vaginal examinations or an average of 2.6 to the patient, with a morbidity of 6.3 per cent.

In 109 cases in which no examinations were made during labor the morbidity was 8.2 per cent.

In the cæsarean group there was less morbidity following vaginal than rectal examinations.

In 238 personal cases in which at least one vaginal examination was made the morbidity was 4.9 per cent; and in 36 patients with only rectal examinations the morbidity was 4.7 per cent.

The slight increase (about 1 per cent) in the morbidity in all the vaginal groups can be accounted for by the fact that vaginal examinations were done on all the more difficult cases and on those with prolonged labors.

	Cases	Morbidity	Per cent morbidity
Total deliveries 1928 to Oct. 1, 1932	9541	672	7.04
Cæsarean sections	325	160	49.1
Deliveries less cæsarean	9216	502	5.4
Corrected morbidity 1930 to Oct. 1, 1932	5271	147	2.7

From January 1, 1930 to October 1, 1932 there were 4 deaths following the vaginal delivery of a viable child; two of these were due to hæmorrhage, one of which had a ruptured uterus; one died from eclampsia and the other from liver necrosis. There were 187 cæsarean sections with 3 maternal deaths.

CONCLUSIONS

The use of mercurochrome as a vaginal antiseptic during labor and at the time of delivery makes vaginal examinations a safe procedure.

The prevailing high stillbirth rate may be due in part to the fact that abnormal conditions are not recognized in time by rectal examinations.

Every patient should have at least one vaginal examination early in the course of her labor; and if labor is not normal, it should be repeatedly checked by a vaginal examination.

NOTE.—Up to the present time, we have had 9,216 viable vaginal deliveries following the present mercurochrome technique, with but a single death from puerperal sepsis.

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MORTALITY FACTORS IN GYNECOLOGY

A Statistical Study of the Deaths from 1902 to 1932 at the Free Hospital for Women, Brookline

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A REVIEW of the current literature reveals a relative lack of discussion of mortality factors as seen in a gynecological clinic. In the last 30 years 17,695 patients have been treated at the Free Hospital for Women, making a relatively large group suffering from gynecopathic disorders. The majority of patients at this clinic present conditions which require surgical intervention, and our attention is focused, therefore, mainly on the postoperative mortality. Figures are also presented on non-operative deaths and terminal cancer deaths. The latter group represents a fairly large proportion of the total deaths, since the hospital has a special ward devoted to the care of these patients.

From January 1, 1902, to January 1, 1932, 262 deaths occurred, divided for our purposes into 95 cases of terminal malignancy, 19 cases not operated upon, and 148 cases the result of operative complications. Seventeen of these patients, 6.5 per cent, came to autopsy. In the remaining cases the statistics are based on clinical diagnosis.

Of the 95 cases of terminal malignancy, 19 had never been treated surgically; 63 had had surgical treatment, but the interval between operation and death was of sufficient length to justify the elimination of surgical intervention as a contributory factor. In the remaining 13 cases, death occurred within 1 month of operation. Nine of these had had exploratory laparotomy for inoperable malignancy; the 4 others had had palliative curettage and cauterization for extensive carcinoma of the cervix. Although we do not believe that operation was a definite factor in these fatalities, it is necessary to consider that death may have been hastened by operative measures.

In the next group of 19 non-operative deaths, the causes were distributed as shown in Table I.

TABLE I.—NON-OPERATIVE DEATHS

Influenza (epidemic 1918)	9
Pelvic cellulitis	4
Pyelonephritis	2
Miscellaneous (intestinal obstruction, urinary suppression, obstructive jaundice, generalized peritonitis)	4
Total	19

The patient having intestinal obstruction was admitted in a moribund condition 1 week after the onset of symptoms. The case with peritonitis showed, at autopsy, inoperable cancer of the rectum with perforation.

OPERATIVE MORTALITY

During the 30-year period studied, 16,829 operations were performed. There were 148 deaths directly attributable to the operation or postoperative complications, a gross mortality of 0.96 per cent. For purposes of comparison we cite the following figures from other clinics, gynecological or general. Norris, in 1929, published a study of a series of 4,212 gynecological operations with 24 deaths, a mortality of 0.57 per cent. Peterson presented a series of 1,734 operative cases with a 0.58 per cent mortality, or 16 deaths. Polak and Tallefson recorded a series of 3,125 operations with 95 fatalities, or a mortality of 2.9 per cent.

Harris says that in contrast to the appalling surgical (and medical) mortality of the eighteenth century, today mortality from elective operations is almost negligible, ranging from 0.5 to 1.5 per cent. Loria presented statistics covering a period of 7 months of gynecological treatment at the Charity Hospital in 1928 and 1929, showing 31 deaths from 2,025 admissions, a mortality of 1.53 per cent. His figures for all surgical deaths in a general hospital were 317 deaths in 5,059 admissions, or a 6.26 per cent mortality.

In our study it seemed desirable to classify the surgical procedures roughly as to their extent and as to the anæsthetic agent employed (Table II).

TABLE II.—EXTENT OF OPERATION AND ANÆSTHESIA

Type of operation	Anæsthesia					No anæsthesia	Total
	Ether	Spinal	Gas oxygen	Novocain	Avertin		
Plastic	5,340	5	34	2	0	145	5,526
Laparotomy	3,338	5	5	9	0	0	3,357
Double	6,987	13	0	0	1	0	7,001
Breast operations	507	0	1	2	0	7	517
Examination	101	0	5	0	0	0	106
Miscellaneous	265	8	6	27	0	16	322
Totals	16,538	31	51	40	1	168	16,829

In the classification in Table II the operations included under the various headings are defined as follows:

Plastic. This group comprises all procedures performed in the lithotomy position, ranging from simple dilatation and curettage to complete reconstruction of the pelvic outlet. Hæmorrhoidectomy has also been included in this group.

Laparotomy. This group includes all cases in which the peritoneal cavity was opened through the anterior abdominal wall.

Double refers to those cases in which the two above operations were performed at the same time.

Breast operations. Include resection, simple amputation, and radical amputation. Ten in which radium treatments were given for recurrence of malignant disease are also included. In 6 of these cases of recurring malignant disease the treatment was given without anæsthesia; in the 4 others ether was used.

Examination means bimanual pelvic examination under an anæsthetic.

Miscellaneous includes all operations not falling into the preceding classifications. Though mostly minor in type, various major procedures are included, e.g., 132 kidney operations.

GROSS OPERATIVE MORTALITY

The operative mortality of *plastic* operations was 0.22 per cent in a series of 5,526 cases.

The operative mortality of *laparotomy* operations was 59 in a series of 3,357 cases, or 1.2 per cent.

For the *double* operation group there were 65 deaths in 7,001 cases, or an operative mortality of 0.93 per cent. The higher mortality in the *laparotomy* group is accounted for by the fact that many of the cases of cancer fall into this classification.

Norris gives a series of 2,439 vaginal cases (plastic) with 8 deaths (0.32 per cent), while his abdominal (laparotomy) cases show a mortality of 0.89 per cent, with 12 deaths in 1,345 operations, and the combined (double) operations, 428 in number, show 4 deaths, or a mortality of 0.93 per cent. Peterson divides his 1,734 cases into 527 major operations and 1,208 plastics, with no deaths in the plastic series.

SPECIFIC OPERATIVE MORTALITY

Here we present tables showing the incidence of death from operations for a specific pathological condition, to illustrate the prevailing causes of death resulting from that particular operation as occurring in our series.

PLASTIC OPERATIONS

Complete perineorrhaphy. Repair of complete laceration of the perineum was done on 270 patients. There were three deaths, an operative mortality of 1.1 per cent. Uræmia, peritonitis, and pneumonia accounted for one death each.

Curettage and cauterization for carcinoma of the cervix. This operation was performed before the advent of radium as a palliative procedure in advanced cancer of the cervix in 121 cases. There were 2 deaths, both due to operative shock. The mortality is thus 1.7 per cent.

Vulvectomy. Complete vulvectomy was done on 29 patients. In 4 of these dissection of the groins was also carried out. Partial vulvectomy was performed in 8 cases. There were no deaths in this group.

Vaginal hysterectomy. This operation has been performed only 8 times in the last 30 years in this hospital. There was no operative mortality.

Other vaginal operations. In this group are included all plastic operations not already specifically classified. Operation was performed on 5,090 patients. There were 7 deaths, an operative mortality of 0.14 per cent. Cerebral hæmorrhage and operative shock accounted for 1 death each. Peritonitis accounted for the 5 remaining fatalities. In all of these cases a septic process was present in the pelvis at the time of operation. Two patients had vaginal drainage of pelvic abscesses. One had an infected ovarian cyst with twisted pedicle, which was drained by vagina, in 1902. Another patient had pelvic cellulitis following an attempted abortion and was delivered of a macerated fetus. The fifth patient had a dilatation and evacuation of a small pyometra. Autopsy on the next day showed a large carcinoma of the sigmoid with generalized peritonitis.

If we exclude these 5 cases and thus obtain statistics for the "clean" vaginal operations, the mortality becomes 0.04 per cent.

It should be noted that this group includes the vaginal application of radium to 1,274 cases. Of these 1,162 operations were performed under ether and 112 without anæsthesia. There were no deaths in this group of radium treatments.

LAPAROTOMY AND DOUBLE OPERATIONS

Supravaginal hysterectomy. There were 2,733 operations for supravaginal hysterectomy, with a mortality of 47 cases or a percentage of 1.7 (Table III).

Masson stated that the mortality from either supravaginal or complete hysterectomy should not exceed 2 per cent, and cited 217 subtotal hysterectomies at the Mayo Clinic in 1926 with 4

deaths, a mortality of 1.8 per cent. Graves (5) described 1,399 personal cases with 22 deaths, a mortality of 1.57 per cent. Burch and Burch, in a protest against the statements that mortality from hysterectomy was low, gave statistics on 166 operations for supravaginal hysterectomy with a mortality of 4.2 per cent.

TABLE III.—SUPRAVAGINAL HYSTERECTOMY

Classification	No. of deaths	Total	Deaths	Per cent
Fibroids (and leiomyosarcoma)	..	1005	16	1.6
Causes of death:				
Under ether	6			
Ileus—adynamic	2			
dynamic	1			
Peritonitis	2			
Pulmonary embolus	1			
Operative shock	1			
Acute nephritis	1			
Myocardial failure	1			
Purpura hæmorrhagica	1			
	16			
Pelvic inflammatory disease (including tuberculous)	..	829	11	1.3
Causes of death:				
Peritonitis	4			
Operative shock	3			
Typhoid fever	1			
Under ether	1			
Intestinal obstruction	1			
Pneumonia	1			
	11			
Prolapse and procidentia	..	406	11	2.7
Causes of death:				
Pulmonary embolus	4			
Myocardial failure	3			
Pneumonia	2			
Operative shock	1			
Sepsis (? source)	1			
	11			
Endometriosis (and adenomyoma)	..	84	1	1.2
Cause of death:				
Pneumonia	1			
Benign ovarian cysts	..	118	2	1.7
Causes of death:				
Urinary suppression	1			
"Exhaustion"	1			
	2			
Malignant ovarian cysts	..	48	4	8.3
Causes of death:				
Under ether	2			
Myocardial failure	1			
Operative shock	1			
	4			
Superfluous uterus*	..	55	1	1.8
Cause of death:				
Pneumonia	1			
Extra-uterine pregnancy	..	19	1	5.3
Cause of death:				
Myocardial failure	1			
Functional uterine bleeding		110	0	0
Carcinoma of cervix		6	0	0
Carcinoma of endometrium		32	0	0
Carcinoma of tube		3	0	0
Bicornuate uterus		7	0	0
Epilepsy		7	0	0
Hæmatometra		1	0	0
Sterilization		1	0	0
Cirsoid aneurism		1	0	0
Hæmatoma of broad ligament		1	0	0
Total supravaginal hysterectomies		2733	47	1.7

*Under "superfluous uterus" are included those cases in which the pelvic organs have passed their period of active function and are so definitely the focus of symptoms, although they are not diseased, that their removal seems justified.

Miller reported 2,991 cases of supravaginal hysterectomy for *fibroids*, with 146 deaths or a mortality of 4.9 per cent. Graves (5) reported 754 cases, with 6 deaths, a mortality of 0.79 per cent.

Complete hysterectomy. Table IV shows the operative mortality and causes of death in 329 patients who had complete hysterectomy performed for various conditions, including cancer. This series as a whole shows a mortality of 7.9 per cent attributable to operation. Complete hysterectomy was performed in 229 cases at the Mayo Clinic in 1926 with 3 deaths, a mortality of 1.3 per cent (Masson 12). Graves (6) published statistics, on a series of 119 cases of complete hysterectomy for carcinoma of the cervix performed by Pemberton and himself with 6 deaths, or an immediate mortality of 5 per cent. He also cited figures of Cobb, who reported a mortality of 5 per cent in 30 cases. Burch and Burch report a 3.1 per cent mortality in 32 cases of complete hysterectomy.

TABLE IV.—COMPLETE HYSTERECTOMY

Classification	No. of deaths	Total	Deaths	Per cent
Carcinoma of cervix	..	120	10	8.3
Causes of death:				
Operative shock	4			
Pneumonia	2			
Pulmonary embolus	1			
Myocardial failure	1			
Urinary suppression	1			
Under ether	1			
	10			
Carcinoma of endometrium	..	72	8	11.1
Causes of death:				
Peritonitis	3			
Pulmonary embolus	2			
Pneumonia	1			
Myocardial failure	1			
Coronary embolus	1			
	8			
Fibroids (and leiomyosarcoma)	..	50	4	8.0
Causes of death:				
Operative shock	2			
Peritonitis	1			
Pulmonary embolus	1			
	4			
Pelvic inflammatory disease	..	50	1	2.0
Cause of death:				
Pneumonia	1			
Functional uterine bleeding	..	11	1	9.1
Cause of death:				
Pulmonary embolus	1			
Vesicovaginal fistula	..	1	1	100.0
Cause of death:				
Under ether	1			
Endometriosis (and adenomyoma)		5	0	0
Prolapse and procidentia		6	0	0
Superfluous uterus		5	0	0
Malignant ovarian cysts		4	0	0
Benign ovarian cysts		3	0	0
Pyometra		1	0	0
Chorio-epithelioma		1	0	0
Total complete hysterectomies		329	25	7.9

Repair of postoperative ventral hernia. It is interesting that in this group of 284 cases, all subjected to long and extensive operative procedures, the mortality was only 1.1 per cent, with 3 deaths.

TABLE V.—REPAIR OF POSTOPERATIVE VENTRAL HERNIA

Classification	No. of deaths	No. of operations	Deaths	Per cent
Postoperative ventral hernia	..	284	3	1.1
Causes of death:				
Malignant endocarditis	1			
Under ether	1			
Pulmonary embolus	1			
	3			

Gall-bladder operations. One hundred and thirty patients underwent operation for gall-bladder disease. Cholecystectomy was performed in 88 cases and cholecystostomy in 42. The common duct was drained in relatively few cases in this series. There was 1 death in this group, an operative mortality of 0.77 per cent. Death was due to subdiaphragmatic abscess and duodenal fistula, 3 weeks following choledochostomy. Harris discussed 1,113 operations reported by Judd and Walters at the Mayo Clinic in 1929. Of these 771 were cholecystectomies with a mortality of 1.4 per cent. Another report of 984 cases gave a death rate of 2.9 per cent.

Other abdominal operations. Into this group fall all abdominal operations which are not classified in the specific groups reviewed above, e.g., myomectomy, appendectomy, salpingectomy, oophorectomy, suspension of uterus, etc. We appreciate that this represents a heterogeneous group of cases, but it does not seem desirable to subdivide them further. In many of the cases a plastic operation was combined with the abdominal procedure. There were 47 operative deaths in 6,868 operations, or a mortality of 0.68 per cent. Nine of the deaths were in patients who had either inoperable abdominal malignancy (6) or generalized peritonitis (3) at the time of operation. Excluding these deaths the mortality for this group becomes 0.51 per cent. By far the largest subdivision of this group of other abdominal operations is that of suspension of the uterus, approximately three thousand of these cases consisting of Olshausen's operation. Graves and Smith (8) gave an elaborate table of 3,358 cases from 1890 to 1928, which includes many of the same patients discussed in our paper. They tabulated 15 deaths attributable to operative procedure for suspension of the uterus, a mortality of 0.45 per cent. This figure corresponds so closely to our corrected figure of 0.51 per cent that it serves to illustrate the persistent mortality from so-called minor abdominal cases. There seems to be a fairly constant mortality from gynecological laparotomy for minor causes of about one-half of one per cent.

TABLE VI.—OTHER ABDOMINAL OPERATIONS

Classification	No. of deaths	Total	Deaths	Per cent
All other abdominal operations	..	6868	48	0.68
Causes of death:				
Peritonitis	13			
Pulmonary embolus	11			
Pneumonia	6			
Operative shock	5			
Under ether	5			
Myocardial failure	4			
Acute endocarditis	1			
Cerebral hæmorrhage	1			
Urinary suppression	1			
Wound rupture	1			
	48			

GENITO-URINARY OPERATIONS

Fifty-five nephrectomies were performed, with 2 deaths; 1 attributed to peritonitis and the other to operative shock, a mortality of 3.6 per cent. Nephrotomy was done on 21 patients. There were 2 deaths, an operative mortality of 9.5 per cent. One patient died of acute urinary suppression and the other of intestinal hæmorrhage of unknown origin.

In 43 cases nephropexy was done. There were no deaths in this group.

Ureterotomy was done in 10 cases without operative mortality.

Decapsulation of the kidney was performed on 3 occasions. Two of the patients died, a mortality of 66.7 per cent. One of these deaths was due to acute toxic nephritis due to iodine poisoning, for the relief of which the operation was undertaken. In the other case pyelonephritis was found at operation and decapsulation of the kidney was done.

Suprapubic cystotomy was carried out on 12 patients. There were 2 deaths, a mortality of 16.7 per cent. Both deaths were due to peritonitis. In one of these cases a transperitoneal approach was employed.

BREAST OPERATIONS

Radical mastectomy, with removal of both pectoral muscles and axillary dissection, was performed in 212 cases with two deaths, a mortality of 0.94 per cent. One death was due to cerebral hæmorrhage. The other occurred suddenly following one of a series of intravenous treatments with colloidal lead for carcinoma. It was considered that death was due to either pulmonary embolism or some allergic phenomenon. There is some question whether or not this should be considered an operative death.

Following simple mastectomy there were two deaths out of 113 cases, a mortality of 1.8 per cent. One was due to diabetic coma and occurred previous to the introduction of insulin. The other resulted from surgical shock following a palliative operation for advanced carcinoma.

CAUSES OF DEATH

Classified by causes, the 148 deaths in this series fall into the groups shown in Table VII. The percentage of the total number of deaths represented by each group is also given, together with the average age of the patients.

TABLE VII.—CAUSES OF DEATH

	Deaths	Per cent	Age (years)
Peritonitis	34	22.9	37.5
Shock	22	14.9	49.0
Pulmonary embolus	21	14.2	52.4
Under ether	18	12.3	41.1
Pneumonia	16	10.8	44.3
Myocardial failure	11	7.4	55.0
Renal complications	8	5.4	43.3
Miscellaneous	8	5.4	55.5
Acute myocarditis and coronary embolus	4	2.7	46.5
Intestinal obstruction	3	2.0	48.0
Cerebral accident	3	2.0	55.3

Peritonitis. The greatest single cause of death is thus peritonitis, occurring in 34 cases and accounting for 22.9 per cent of the deaths. The average age of these patients was 37.5 years. Of these deaths 14 followed laparotomy. Thus death from peritonitis occurred in 0.42 per cent of the 3,357 laparotomies done. In 3 of these cases acute peritoneal infection was present at the time of operation. Deducting these to get a corrected figure for "clean" cases we get 0.33 per cent mortality. Four of these cases had chronic pelvic inflammation at the time of operation.

Eleven deaths occurred after double operations, 0.16 per cent of the 7,001 done. One of these patients had peritonitis at operation, the corrected figure becoming 0.14 per cent.

Six deaths from peritonitis followed plastic operations, of which there were 5,526, a mortality of 0.11 per cent. Five of these 6 cases had an acute septic process in the pelvis at operation, giving a corrected figure for "clean" cases of 0.018 per cent.

Of 12 operations for suprapubic cystotomy, 2 patients died, a mortality of 16.7 per cent. In 1 of these the transperitoneal route was used.

One patient in the group of 132 kidney operations died of peritonitis, a mortality of 0.76 per cent. Nephrectomy for tuberculosis of the kidney and ureter was performed in this case.

Operative shock. Twenty-two patients died from this cause, 14.9 per cent of the total. The average age in this group was 49.0 years.

Ten of these deaths, or 45.5 per cent, followed operations for malignancy. Complete hysterectomy for carcinoma of the cervix was performed upon 4 of them. In one of these cases operated upon in 1902 it was necessary to resect the bladder and implant both ureters in the vagina. Two patients died of operative shock after curettage and cauterization for extensive cervical cancer. Following exploratory cœliotomy for advanced abdominal malignancy, 2 deaths occurred. One patient died following supravaginal hysterectomy for bilateral malignant ovarian cysts with metastases in the abdominal wall. Another patient died following palliative simple mastectomy for advanced carcinoma of the breast with metastases to ribs and mediastinum.

Operations for fibroids accounted for 5 deaths from shock, or 22.7 per cent of the deaths in this group. Supravaginal hysterectomy accounted for 2 of these deaths and complete hysterectomy and myomectomy for 1 death each. The fifth patient was moribund on admission. Enucleation of a sloughing fibroid and delivery of a macerated fetus was performed *per vaginam.*

Supravaginal hysterectomy for pelvic inflammatory disease resulted in death from operative shock in 3 cases. This constitutes 13.6 per cent of this group.

The 4 remaining deaths followed supravaginal hysterectomy for prolapse, nephrectomy for hydronephrosis, excision of retroperitoneal dermoid cyst, and excision of retroperitoneal fibroma.

Pulmonary embolus. This complication was the cause of death in 21 cases, 14.2 per cent of the total. The average age of this group, 52.4 years, corresponds with the findings of Badgley and Smith, who state that patients past 50 years of age are prone to pulmonary embolism. The average postoperative interval was 9.0 days. An abdominal operation had been performed in all cases. Hysterectomy, either complete or supravaginal, was done in 10 of the 21 cases in this group.

In 4 cases the operation was done for cancer. One patient had a complete hysterectomy for postmenopausal bleeding at the age of 65, although no malignancy was found. This occurred previous to the use of radium in the treatment of these cases.

The underlying pathology was leiomyomata in 2 cases and in 1 patient the operation was performed for repair of a postoperative ventral hernia.

The remaining 13 patients, or 61.9 per cent of all cases in this group, died of pulmonary embolism following operations for prolapse and procidentia. It is disturbing to find such a large proportion of fatal pulmonary emboli occurring in patients subjected to what are essentially operations of election.

Under ether. Deaths occurring under ether, on the operating table, accounted for 18, or 12.3 per cent of the total fatalities. The average age of these patients was 41.1 years, somewhat under the

average of the group as a whole. The average length of operation in the 15 cases in which data are available was 68 minutes.

All patients dying under ether had abdominal operations. Hysterectomy was performed in 11 of the 18 cases. It was done for fibroids in 6 cases, for malignant ovarian cysts in 2 cases, and in 1 patient each for carcinoma of the cervix, pelvic inflammation, and vesicovaginal fistula.

Double reconstructive operations for prolapse accounted for 3 deaths under ether. Repair of ventral hernia, oophorectomy for malignant cyst, and exploratory cœliotomy for intestinal obstruction accounted for the 3 remaining deaths.

Of the 18 patients, 4 were definitely poor operative risks. One case, with a malignant ovarian cyst, was 78 years of age and had a blood pressure of 180–90 with a history of a preceding cerebral accident. One patient with pelvic inflammatory disease had a bad rheumatic heart lesion. Another patient had carcinoma of the cervix, had lost 20 pounds in 2 months and her general condition made her a poor risk. The fourth patient had intestinal obstruction 6 days after supravaginal hysterectomy for pelvic inflammation and was in poor condition at the time of the second operation.

The 14 remaining patients were satisfactory operative risks, in so far as could be determined. It is fairly generally conceded by authorities on anæsthesia that deaths occurring under ether in patients who are in good physical condition must be attributed to the anæsthetic agent. There is considerable variation of opinion as to the frequency of such deaths under ether. Cushny gives 1 death for every 10,000 cases as a good general average. Kaye states that death from ether in certain public general hospitals is as high as 1.3 per cent. During the period studied, ether was administered 16,538 times with 14 fatalities, an incidence of 1 case in 1,181 or .085 per cent. Since all the deaths under ether occurred during abdominal operations, it is interesting to note that considering this group alone we find 14 deaths in 10,325 operations, an incidence of 0.15 per cent. It is perhaps remarkable that anæsthesia accidents are not more frequent in this hospital, as the ether is given in most cases by medical students, although under the careful supervision of a competent anæsthetist.

Cushny states that in the majority of the accidents occurring under ether, overdosage is the cause. He further states that experimental work has shown that in deaths of this type the heart always continues to function after respirations have ceased. How long the heart will continue to function depends on how much cardiac damage has occurred before respirations cease. This in turn depends on the concentration of the ether vapor that the patient has been inhaling; the more concentrated the vapor the more extensive is the cardiac damage. When very concentrated vapor is used the interval is inappreciable and the pulse may be so weak as to be imperceptible to the anæsthetist before respirations cease.

Kaye, in an exhaustive study of anæsthetic deaths coming to autopsy, reported 22 deaths under ether during 1919 to 1929. He stated that the manner of death was primary circulatory failure in 7 cases and primary respiratory failure in nine. In 2 cases failure of pulse and respiration seemed synchronous and in 4 patients the point could not be decided. At autopsy cardiac failure apparently describes all but one of his series, about which he commented that there was no organic lesion. His conclusions from a study of 107 deaths under anæsthesia were that "every general anæsthesia involves a small but definite risk, of the order of perhaps 1.3 per 1,000." He does not state whether or not the head was examined.

We are also reminded by Sollman that patients died on the operating table before anæsthesia was used. He says: "In pre-anæsthetic days the French surgeon Desault drew his fingernail over the perineum of a patient to mark the line of incision, when the patient gave a cry and was dead."

Cushny and Sollman agree that autopsies in cases of acute ether deaths show nothing beyond the usual phenomena of asphyxia. Merrell reports 4 cases in detail. Three of the deaths are attributed to "bleeding into the tissues," corresponding to the so-called "shock." The fourth case was due to fat embolism. In the first 3 cases the patients had a bright red color when death occurred, due to peripheral vasodilatation. He concludes, therefore, that color cannot be taken by itself as an indication of the well-being of the patient.

Autopsies were done on 2 of our cases. One of them was entirely negative. The head was not examined in this case. The second case showed a marked cerebral œdema and was otherwise negative.

Pneumonia. The seasonal incidence is the outstanding feature of the group of 16 patients who died of postoperative pneumonia. Fourteen, or 87.5 per cent, of them died during the October to April period, while only 2 died in the May to September interval.

The gross mortality due to pneumonia in patients who received ether was very low, being

16 out of 16,538, or 0.096 per cent. All but one of the 16 patients had had an abdominal operation. The one remaining case came following repair of a complete laceration of the perineum.

Graves (7), reporting on 2,000 consecutive cases without a death at the Free Hospital for Women in 1910 (which cases are included in our study), said, "The absence of mortality in the Free Hospital cases confirms Risley's observation that postoperative pneumonia or bronchitis in clean cases is of shorter duration and of less serious nature than in septic cases, the majority of the Free Hospital cases being clean cases." He further quoted Homans' series of 3,280 gynecological cases with 257 deaths (7.83 per cent), 50 of these deaths being due to lung complications, or 1.53 per cent.

While not a gynecological report, the excellent paper of Cutler and Hunt, in 1920, on "Postoperative Pulmonary Complications" affords an interesting comparison of statistics from a general surgical clinic, with its necessarily septic cases, with figures from a comparatively "clean" series. They reported 8 deaths from pneumonia in 1,562 cases, or 0.51 per cent. Their study of statistics from 9 other papers in addition to their own series gives one a bird's eye view of 41,368 operations with a death percentage from pneumonia of 0.41. It would appear that the low figure at the Free Hospital for Women might also be attributed to the fact that our patients receive 2 or 3 days of treatment before operation, consisting of rest and bowel management, surely a large factor in improving any patient's operative risk.

Cardiac complications. In 11 cases, 7.4 per cent of the total fatalities, death was attributed to acute myocardial failure with cardiac dilatation. The average age in this group was 55.0 years. Here, as in fatal pulmonary emboli, we find double operations for prolapse and procidentia accounting for a large proportion of the deaths, in this instance 6 of 11 fatalities. Only one of these 6 patients had any definite findings on physical examination to indicate cardiac disease. This case showed a blood pressure of 234–130, even after a considerable period of rest in bed.

One patient with carcinoma of the cervix had a rheumatic heart lesion without history of decompensation. She died of acute myocardial failure following complete hysterectomy.

There were 4 additional cardiac deaths. Two were due to acute endocarditis, 18 days and 1 month after operation. One of these patients had a definite pre-existing rheumatic lesion. There was no clinical evidence of one in the other case.

In one patient death was attributed to coronary embolism and in another to acute myocarditis.

Renal complications. Eight patients died of renal complications. Their average age was 43.3 years. They represent 5.4 per cent of the total deaths. In 4 cases death was due to urinary suppression, to acute nephritis in 2 patients, and to uræmia and pyelonephritis in 1 case each.

The urinary suppression was mechanical in nature in 1 of the 4 cases mentioned, both ureters having been ligated in the course of a difficult hysterectomy.

In 132 kidney operations, there were 3 deaths due to renal complications, a percentage of 2.3. In 2 of these the factor causing death was present at the time of operation, being pyelonephritis in 1 case and acute toxic nephritis following iodine poisoning in the other.

There were 4 deaths due to renal complications out of 3,357, a mortality of 0.15 per cent from this cause. Out of 5,526 plastic operations done 1 patient died of uræmia, giving 0.018 per cent. This patient gave a history of "Bright's disease" and showed a trace of albumin in her urine before operation.

Intestinal obstruction. There have been 3 postoperative deaths due to intestinal obstruction in the past 30 years. All 3 patients had laparotomies and all had supravaginal hysterectomy for fibroids. In 1 case the obstruction was paralytic in type, while in the 2 others it was dynamic. Both of the latter had secondary exploratory laparotomy performed for relief of the obstruction.

Cerebral accident. Three patients died following cerebral accidents. Two were definite cerebral hæmorrhages in elderly patients, 1 following a plastic for procidentia and 1 after radical mastectomy for cancer. The third patient was a young single woman aged 30 years, who had a double operation for pelvic inflammatory disease. She died 12 hours after operation in convulsions, with extreme cyanosis. This was interpreted as some sort of cerebral accident.

Miscellaneous. Eight patients died of miscellaneous causes, constituting 5.4 per cent of the total fatalities.

One patient died of subdiaphragmatic abscess and duodenal fistula 3 weeks after choledochostomy. Another patient died of hyperpyrexia of unknown origin, 2 months following a two-stage double operation for procidentia. It was felt that she probably had some obscure focus of sepsis, but exploratory cœliotomy failed to reveal the nature of the process.

A diabetic patient with carcinoma of the breast died ... coma 8 days after simple mastectomy

under ether anæsthesia. This occurred previous to the introduction of insulin.

Another patient died suddenly after an intravenous injection of colloidal lead for cancer. This happened 12 days following radical mastectomy. Death was attributed either to pulmonary embolism or some allergic reaction.

Two patients died of intestinal hæmorrhages. One of them had thrombocytopenic purpura. The etiology of the bleeding could not be determined in the other case.

A 74 year old woman failed gradually and died of "exhaustion" 7 weeks after supravaginal hysterectomy for large bilateral benign ovarian cysts. No specific cause of death could be found in this case.

Another patient, 65 years of age, had an exploratory laparotomy with evacuation of ascitic fluid and cyst contents, for inoperable malignant cystadenoma of the ovary. Two weeks later she developed a total right hemiplegia with loss of speech. Five days later she had recovered her power of speech and a large degree of muscular control, when her wound ruptured throughout its entire length. The wound was resutured under novocain anæsthesia, but nevertheless, the patient died a few hours later.

SUMMARY AND CONCLUSIONS

1. The 262 deaths occurring during the past 30 years at the Free Hospital for Women have been studied. They have been divided into 95 cases of terminal malignancy, 148 postoperative deaths, and 19 cases not operated upon.

2. Autopsy was performed on 6.5 per cent of the cases.

3. The terminal malignancy and non-operative groups have been briefly analyzed.

4. The gross operative mortality for all operations performed was 0.96 per cent. Comparative statistics have been cited.

5. The various operations have been classified roughly by degree of difficulty and the mortality for each group has been computed.

6. The mortality from *plastic* operations was 0.22 per cent for 5,526 cases. In 3,357 *laparotomy* cases the mortality was 1.2 per cent, and in 7,001 *double* operations it was 0.93 per cent.

7. The causes of death following various operations for specific pathological conditions have been given in detail, and the outstanding causes have been discussed.

8. The operative deaths have been divided into groups according to cause of death. Each group has been studied and a summary of the analysis given.

9. Special attention has been given to cases dying under ether during operation.

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EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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THE CLINICAL PATHOLOGICAL CONFERENCE

THE importance of holding clinical pathological conferences is almost universally recognized. Not so commonly emphasized is the importance of suitably staging such conferences, in order that the utmost benefit under the least distressing circumstances may be achieved. That the morgue or the pathological laboratory are usually poorly adapted places and that the chosen room should be comfortable, well lighted, and well ventilated may be stated without argument. Other features, however, may merit more careful consideration.

Often one of the weakest points in the meeting is the method or manner of presentation of the clinical history. To watch an interne or a staff physician thumb over a voluminous collection of clinical notes and then listen to him attempting to read all sorts of findings, most of them irrelevant and immaterial, is not only time consuming, but it is likely to "kill" the meeting almost before it starts. The strictly essential data about any patient may be presented in a very few words. Better yet a lantern slide may be made, containing every clinical fact which is necessary to note concerning the case under discussion. This procedure has the advantage of focusing the attention of the audience on the single case, and the various details of that patient's story may be supplemented by comments or questions.

The proper presentation of the gross specimens is another element in the success of the conference. The passing around on a dirty plate or tray of a wet specimen which reeks with formalin, which is handled at one's peril, and which shows very poorly the lesion it is supposed to represent, certainly becomes a severe test of the fortitude and enthusiasm of those who are in attendance. With only a little more diligence the pathological specimen obtained at necropsy or operation may be trimmed intelligently and so sectioned or dissected as to reveal the diseased area to the best advantage. It may then be fixed in any of the various modifications of Kaiserling's fluid for the purpose of partially restoring its original color values. Immediately before the meeting the specimens may be removed from the jars, excess fluid wiped off and the surfaces painted with a warm 15 per cent solution of gelatin, put on with a soft camel's hair brush. With this gelatin film the specimens will not dry so quickly, they retain their colors and sheen, and can be easily handled without soiling the hands or contacting them with offensive odors. Instead of being passed around they may be placed on clean, neat trays arranged on tables high enough so that too much stooping will be avoided, and each specimen may be identified as to organ

and lesion by an appropriate label in close proximity. Then the audience may be invited at any time before, during, or after the meeting to inspect these specimens, well lighted and well displayed. During the presentation of the pathological features of the case additional but not essential refinement may be effected by showing lantern slides which depict by photography the gross appearances of the disease process. This photography may add a rather important feature as the camera can magnify the picture, thus revealing the finer details which might be lost to the unaided eye. The photograph also becomes a part of the permanent record.

No conference is complete unless the microscopic features are presented. This may be best accomplished through a microprojection lantern, but stained sections under microscopes may serve as a substitute. The advantage afforded by the lantern is the opportunity for demonstration and discussion.

Lastly, the spirit pervading the conference must be marked by enthusiasm for the truth, forbearance toward the mistakes of others, and frankness in acknowledging one's own errors. Brevity, clearness, attractive presentation of specimens, considerate regard for the other fellow, and the earnest endeavor to draw helpful conclusions will make a clinical pathological conference one of the most valuable meetings which any physician can attend.

H. E. ROBERTSON.

IS SKIN GRAFTING WITH ISOGRAFTS OR HOMOGRAFTS PRACTICABLE?

SOMETIMES quite competent surgeons pander to the wondering delight of a credulous laity, and mother, brother, and even friends are encouraged to give up a part of their skin to some poor injured soul. But unkind fate as yet seems to have decreed that such a sacrificial offering on the altar of a sympathetic and generous martyrdom is doomed to failure; for both experimental and practical evidence indicate that isodermic skin grafting is not practicable except possibly from identical twin to identical twin.

Recently the great importance of the relative nearness of the relationship between the host and the transplant as the principal factor that determines the fate of the graft has been recognized in its full significance. Loeb[1] found that in skin transplantation from animal to animal, the length of time the graft remains viable depends upon the amount of leucocytic and fibroblastic reaction shown by the host against the graft and the intensity of the reaction depends upon the nearness of the blood relationship of the donor to the recipient. More recently, in the human Loeb's findings have been substantiated by a series of experimental skin transplants (forty-four in number) performed by Padgett[2].

Briefly, the result to be expected after isodermic skin transplantation may be summarized as follows: An immediate "take" occurs in the majority of cases. In non-related individuals, between the second and third week, the grafts begin to disappear and by the end of the fourth week have completely disappeared. Individuals related by blood (syngenesio-transplantation) such as father to son or even uncle to nephew, the graft "takes" and remains viable about three weeks but by the end of the fifth week it is destroyed. In identical twin transplantations (the closest possible syngenesio- or near relation transplantation) the grafts have remained *in situ* in 4 cases over 1 year, and it is assumed such grafts may take permanently.

Most likely, certain chemical characteristics, which were designated by Loeb as the

[1] Physiol. Rev., 1930, x, 547.
[2] South. M. J., 1932, xxv, 895-900.

individual differentials are present in most tissue, and are common to a given species. Similarly the tissues of near relatives of different strain, varieties, species, genera, and classes of animals have in common certain chemical characteristics. The tissues of the host assume injurious properties, and toxins are thrown out which destroy the grafts. These differentials determine the degree of intensity of reaction between host and donor.

Experimental work has shown that the substances thrown off by the graft do not act, as a rule, in the nature of antigens and do not call forth the production of secondary (immune) substances on the part of the host which cause the graft to be destroyed. If secondary (immune) reactions were important it might be expected that the homo-reaction following a second transplantation would appear more promptly but no acceleration of time seems to occur. The evidence seems to indicate that individual differentials in homo-transplantation are shown by primary substances given off by the grafts which act as toxins and stimulate the cells of the host to a leucocytic and fibroblastic cellular reaction against the graft.

The hypothesis that these differentials are genetically determined is suggested by the whole series of gradations in reactions found on transplanting tissues into strange hosts. The individual differentials are more closely related within the same family, species, or strain. Consequently, grafts of skin from brother to brother or sister to brother (close syngenesio-transplantation) remain viable the longest after transplantation. A slight decrease in the length of time that the graft remains viable is noted in the case of transplantation of parent to child (a more distant type of syngenesio-transplantation). Experiments in close inbred animals also show similar varying reactions according to the nearness or distance in relationship of the donor and the host. Thus, we conclude that organismal differentials are genetically determined.

Apparently the organismal differentials depend upon the totality of genes which make up the chromosomes which are present in the cells of the host and donor. Presumably the genes or more specifically gene derivatives determine the character of the differentials. The Y chromosomes must have little to do with reaction as it makes little difference whether host or donor are of same sex.

According to the theoretical considerations previously outlined, the improbability that the blood group of the donor and host can be of particular significance is evident. Blood groups probably depend upon a few genes and tend to throw all individuals into approximately four groups, while individuality differential is most likely determined by all or at least a great number of the genes of an individual. Thus, if the theory of organismal differentials holds, it multiplies the possibilities of the strangeness of the tissue of the donor to the recipient to an infinite number.

At the present time, the evidence—both experimental and clinical—is sufficient to justify the following brief conclusions: (a) Autotransplantation of skin usually succeeds. (b) Syngenesio-transplantation of skin is theoretically improbable except in identical twins where it is theoretically probable and clinically has occurred. (c) The failure of experimental isodermic grafts on the human and on animals to remain viable and theoretical reasoning argue against the blood group of the individual as playing a rôle of any essential significance in homotransplantation of skin. (d) And finally, the bulk of experimental and clinical experience is in agreement that iso- or homotransplantation of skin is not practicable except possibly in identical twins. EARL C. PADGETT.

MASTER SURGEONS OF AMERICA

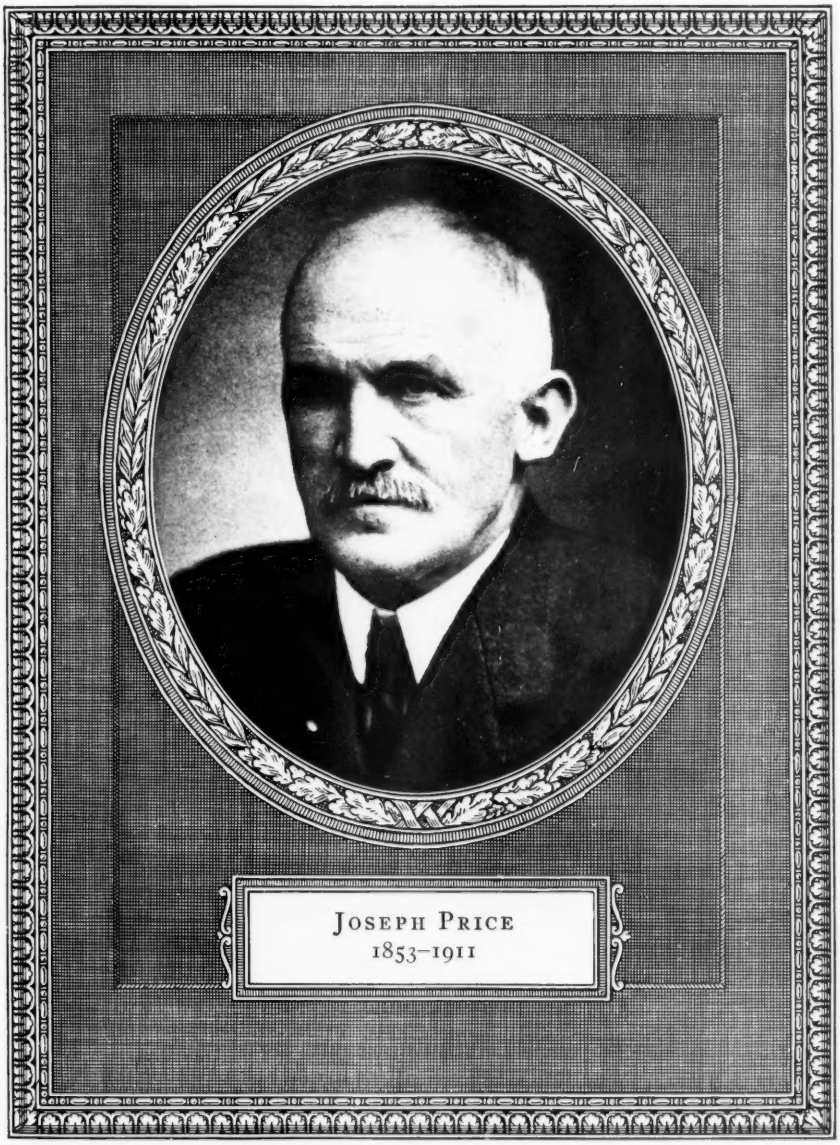
JOSEPH PRICE

ON a plantation in Rockingham County, Valley of Virginia, Joseph Price was born January 1, 1853, the site of his birthplace being but a few miles from that of McDowell. He received his early schooling at Fort Edward, New York, and was later graduated from Union College, New York. He read medicine with his brother Mordecai and was graduated from the Medical Department, University of Pennsylvania, in 1877. He married Miss Louise Troth of Philadelphia and to them were born seven children—three boys and four girls.

Probably the first major operation ever performed by Price was for criminal abortion and he was often heard to say that an operation of this character would be the cause of his death. Strange as it may seem he was at least partly correct, for, in 1909, while operating upon a patient, the victim of a criminal abortion, a wound in his finger became infected and he never entirely recovered from the infection. He lived for two years, however, and his remarkable vitality and persistence are shown by the fact that he performed an appendiceal operation the day he died, June 6, 1911.

Dr. Price was about five feet ten inches tall, and weighed one hundred and eighty-five pounds; he had keen, piercing, gray eyes which looked out from beneath shaggy eyebrows. He was endowed with unusual vitality, inexhaustible energy, and was as vigorous in mind as in body. He was a boxer of more than ordinary ability, an excellent rifle and pistol shot, having won the rifle championship at the Philadelphia Centennial. He was a big game hunter; very fond of horses and dogs, in fact of all outdoor life. His home was a museum, his farm a menagerie. He would not soil his hands by rectal or vaginal examinations and in 1908 was heard to say that he had given up his dogs in order to keep clean; and should give up his horses of which he had a great number.

His moods are rather hard to describe. He never seemed in the least excited or worried while actually operating nor was there ever any hesitation; however, it was very common for him to enter the operating room very considerably irritated, "up in the air" we called it. On these occasions he was likely to unload on someone. Once when he had been unusually severe on his brother Mordecai, Dr. Will Mayo said to Mordecai, "Why do you stand it? Give it back to him,"



JOSEPH PRICE
1853–1911

UNIV OF MICH

to which Mordecai replied, "It does not hurt me and does Joe a lot of good." On one occasion the source of his anger was the offer of a Philadelphia politician to secure for the Price Hospital certain state funds. Price no doubt rightly guessed that there would be strings attached and exclaimed, "No, I am the boss here, from the coal heaver to Kennedy. I can fire any of them."

He was dogmatic, whimsical, eccentric, original, forceful, courageous, and usually devoid of diplomacy; *usually* because we must remember that he founded and successfully operated a private hospital, and no man can do that without using some diplomacy. Probably no physician had more friends or more enemies in the profession.

He hated the polished meaningless sentences issuing from the suave gentlemen Sinclair Lewis has styled "men of measured merriment." He was a crusader and looked to the young men to "carry on." He was constantly urging these young men to re-educate themselves, then to go home and do at least emergency surgery, even though the circumstances were very adverse. "Operate in the cotton gins, at the cross roads, in the kitchen, any place to save a life." "Don't let the woman die if you have to tie the pedicle with your shoestring." "I wouldn't give a cent for a young man who hasn't sat up all night and gotten covered with vermin while preparing for an operation the next morning. You must operate upon the poor before you can operate upon the rich." We must remember at the time Price was giving us this advice hospitals were very few and far between, and many people were dying for want of early surgery.

His personality was so powerful and outstanding that he had the absolute confidence and esteem of his patients; to them he was gentleness personified; if the sheets were not just right he would straighten them out himself; then with a smile say, "take a deep breath clear down to the end of your toes and go to sleep."

His professional life may be said to have begun in the Philadelphia Dispensary, in 1877. Here he organized the gynecological and obstetrical departments of this, the oldest free dispensary in America. The actual obstetrical work was done in the homes of the slum cases by senior students who were required to have a cake of soap, a new scrub brush, and material with which to tie the cord. The student was permitted to make only one examination. As the gynecological operations originating in the dispensary were performed in the homes of the patients, it was necessary to develop a simple technique if success was to attend his efforts. Every material used was boiled: instruments, towels, gauze, and sutures. He cleaned up a small circle and stayed within that circle. An ironing board was used for an operating table; on a kitchen table covered with boiled towels he placed his small copper sterilizer containing a very few instruments. "Here under the most unfavorable surroundings at the very dawn of aseptic surgery when it had received no very substantial endorsement by the

leaders of the profession, a master mind dominated the most unsurgical conditions and conquered opposition." In such surroundings he is said to have performed one hundred abdominal operations with but one death.

For eight years he had charge of the Preston Retreat. During this time he wrote and spoke much on clean obstetrics, for which he waged an almost constant battle. It was largely during this period that his dogmatic expressions, harshly spoken words, and lack of diplomacy made him many enemies.

To a man of Price's disposition a private hospital was a necessity, and so we found him establishing his hospital which was four stories high and had an operating room on each floor, "four dollar operating rooms" he termed them. Other than a very small copper sterilizer eight by sixteen there was practically nothing in the operating room that could not be found in any home. The operating table consisted of a broad board which lay on a couple of saw horses, and under the table was a zinc wash tub. If the operation was a vaginal one Price sat on a split bottom chair; similar chairs being provided for the spectators. The legs of the patient were held by two assistants. Of course this was all intended for teaching purposes. Simplicity was a keynote of all he did; he abominated "fuss, feathers, and foolishness."

After the erection of his hospital the patients from the dispensary were cared for there, no charge whatever being made. The amount of charity work done by Dr. Price was enormous; it is one thing to do a charity operation, quite another to bear the hospital expense also. Here Price developed into a great teacher, and to his clinic came men from all parts of the world.

To describe his manner of operating is impossible; the word "ease" comes nearest it. He never seemed to hesitate, never to make the wrong move, but always to make the right move to accomplish the object intended, and he never showed a trace of indecision. He used very few instruments and these were small. His regular layout consisted of one knife, one pair of straight scissors, six hæmostats, if a breast operation twelve, two small clamps, and some straight needles. He used no retractors, no needle holders, no curved needles; he did not use the Trendelenburg or Fowler positions. He used exceedingly few ligatures. On one occasion accompanied by a friend he visited a celebrated clinic; the last operation was a breast amputation during which very many ligatures were used. Upon leaving, for a time he was very silent, then looking up he said, "If that woman dies it will be because she was bitten to death; yes, Stuart, bitten to death." Question, had he already unconsciously worked out the theory of noci-association? He seemed to operate very largely by sense of touch, to have an almost uncanny knowledge of the lines of cleavage; thus in pelvic infections having once introduced his hand he did not remove it until the affected part was enucleated. His work was almost unvarying in its sameness, the patients were always carried in and out of the operating room by two doctors and one

nurse, they were handled always identically the same way, the blankets were always pinned around the patient in exactly the same way.

Dr. Price was one of the first to advise an immediate operation in ectopic pregnancy. In one case he made the diagnosis over the telephone and commanded that the woman be left lying on the floor until he could get there. Upon arriving he made his preparations, then lifted her on the ironing board and successfully operated. He was one of the earliest advocates of immediate operation in appendicitis. This operation he did beautifully with two straight needles and pair of scissors, the entire appendix being cut out of the cæcum. He likened the retrocæcal appendix to the tail of a dog tucked between its hind legs.

Price, was first, last, and all the time a gynecological abdominal surgeon but he was not uninterested in other branches of medicine. We find him discussing sanitation, prevention of typhoid, preservation of milk, and he even wrote an article on the "Conservative Management of Undescended Testicle." He was greatly distressed over the increase of the number of feeble-minded, and believed that they should not be allowed to procreate.

He hated shams of all kinds and was fond of exposing them. A certain physician had been claiming to cure abdominal tumors by electricity and was to read a paper before the county society narrating these cures. At the conclusion of the paper Dr. Price exhibited a large number of tumors which he had removed after they had been treated by the essayist. Of course, many erroneous opinions of Price's surgery exist. Recently a well known surgeon who knew Price in his early days stated that Price did not believe in the germ theory. This hardly seems correct when we consider the terrific scrubbing he gave his hands, face, and head and the large amount of bichloride he used.

We may safely assume that the same brain that placed him in the forefront in his youth kept him abreast of any real progress in his old age.

A man must stand or fall by the judgment of his peers. Dr. William Mayo said, "Dr. Price was the father of abdominal surgery in America. He was a man of fine scientific imagination and most skillful as a surgeon. His greatest work was as an educator." Dr. Robert T. Morris: "His convictions were as strong as those of Martin Luther or John Brown and all his powers were aimed at the fixation of his own ideas upon others." Dr. Howard A. Kelly: "Dr. Price was a pioneer in the newer aggressive surgery and a great leader and teacher; he did more than any man I know to fashion the methods we pursue today. He was brilliant as an operator achieving the greatest results by the simplest methods." Dr. W. W. Babcock: "With the passing of Price, America lost the foremost of its early masters of abdominal surgery."

The writer left Price's clinic one morning in company with a very distinguished surgeon and author. For a time my companion was in deep thought. Finally he looked up and exclaimed, "A Master Surgeon!"

A. P. Butt.

EARLY AMERICAN MEDICAL SCHOOLS

THE INDIANA CENTRAL MEDICAL COLLEGE

WILLIAM N. WISHARD, JR., M.D., INDIANAPOLIS, INDIANA

THIRTY-TWO years after Indiana had attained her statehood, the trustees of the 12 year old Asbury University (now DePauw) nominated Indianapolis, the then frontier State Capitol of some six thousand, as the future site of a medical school to be under their patronage. The parent institution, projected by the Indiana Conference of the Methodist Church in 1835, was incorporated under an Act of the State Legislature in 1837, published the first catalogue in 1839, graduated her first class in 1840, and blossomed from a faculty of 3 and student body of 85 at its inception to a thriving university of nearly three hundred at the end of her first decade. Large contributions having come from Greencastle, the University was founded there, a location, as the first catalogue mentions "as healthy as any part in the West, and while sufficiently easy of access, it presents few of those temptations to vice which are so abundantly found in larger places, or upon the leading thoroughfares."

In 1848 a committee of the Board of Trustees, comprised of E. R. Ames, J. L. Smith, and John Wilkins, formulated details for a Medical Department with five professorships to have full power to govern, maintain, and regulate the school, neither the trustees nor the college resources being in any way financially responsible for it (1).

"The friends of this enterprise at Indianapolis have come forward with their usual liberality and munificence, and offer to fit up, at once, a large and commodious building, having ample space for lectures, dissecting, library, apparatus, and museum. This places the Institution upon an easy footing, and all the arrangements will be completed in the most satisfactory manner, before the time shall arrive specified for commencing the course of instruction.

"The want of such an Institution, thus centrally located, is manifest to everyone who has reflected upon the subject; and the interest awakened in the public mind since the Board of Trustees has taken the subject under consideration gives the best assurance that the enterprise will meet the countenance and co-operation of all who desire to see an improved state of medical learning in Indiana. An announcement will be issued in July next. In the meantime we would say that it is the intention of all concerned to make the Indiana Central Medical College equal to the best in the country" (2).

The faculty (3) selected was as follows: L. Dunlap, professor of surgery and surgical anatomy; J. S. Bobbs, M.D., professor of general and special anatomy; R. Curran, M.D., professor of physiology and pathology; J. S. Harrison, M.D., professor of materia medica, therapeutics, and medical jurisprudence; G. W. Mears, M.D., professor of obstetrics and diseases of women and children; Chas. G. Downing, A.M., professor of chemistry and pharmacy; Tarvin W. Cogwill, M.D., professor of theory and practice of medicine.

That the new school was heralded by no fanfare of trumpets is attested by the paucity of news about it in the public press of that day. One paper (4) located the new medical college on the third floor of the Johnson Building, large enough to handle one hundred and fifty students, went on to say that the central location would make it a medical graduating point for the State, would double the transient population, increase business, and closed by advising the Legislature to move the State University to the same city.

Whatever the Indiana Central Medical College may have lacked in physical endowment was compensated for by the 7 able faculty members, at least 3 of whom still live by reputation in the community. Dr. Dunlap was the first president of the State Medical Society. Dr. Mears provided a permanent income to purchase medical literature for the Indianapolis Public Library. Towering over all was Dr. J. S. Bobbs, the dean of the faculty. Instrumental in the organization of the State Medical Society and prominent during its first 20 years both politically and scientifically, interested in civic affairs of the community, advocate of local educational institutions, first surgeon in the world to perform a cholecystostomy, and donor of Indiana's earliest free dispensary, it is perhaps not unfair to his contemporaries to nominate him as leading physician of the state for the middle third of the nineteenth century. Having

come to Indianapolis some years before 1849 as a graduate of Jefferson Medical College, his already influential position, as well as professional, educational, and administrative talent, was doubtless paramount in causing the decision of the Asbury trustees to venture a medical department.

Dr. Bobbs' attitude toward the local school may be read in his own words (5) years after its demise. As president of the Indiana State Medical Association in 1868 he was replying to an address of a former president, Dr. Kersey, who had asked:

"What do we want with a medical school in Indiana? Surely nothing, unless it be established on a scale and basis to compete in excellence, in eminence, in every appliance and means of instruction with the best schools of the age. It should . . . assume a high rank among our positive luxuries for it could not . . . be regarded in the light of a necessary institution. It should be richly endowed . . . conferring degrees on merit only. Such an institution will be welcome whenever it comes."

Replied Dr. Bobbs:

"We have no doubt of it—such luxuries are like angels' visits, and cannot fail of appreciative recognition whenever they appear without disguise.

"But it suggests the consideration: When this professional millenium may be reasonably looked for? Whose cry in the wilderness will herald its advent?

"That a Medical College will ever be established in this State on an independent basis, and with the wealth of appliance required by this standard is possible—how long it will precede the general resurrection is problematical. That man is given to the indulgence of a lively faith who cherishes the hope of its early realization.

"I cannot resist the conviction that a good medical school . . . in Indiana would tend to the cultivation of medical science. Its influence would be more widely felt . . . . if it aspired to a less exalted position at inauguration. There is a fitness of things which cannot be safely disregarded in the practical affairs of life. It seems to me it requires, in this case, that while we demand a higher standard of qualification in the student, we should couple it with the means of obtaining that platform; and that it will better subserve the interests of the profession and the people to elevate the great body of the former to a creditable position than to attempt to confer eminence on a few and nothing on others."

The medical college opened with 49 students on Monday, November 5, 1849, being located on the southeast corner of Washington and East Streets. Aside from the models, drawings, instruments, anatomical specimens, and other apparatus which it afforded, an opportunity was offered for clinical observations with the professors in their private practice. Courses were given in anatomy, physiology, therapeutics, medical jurisprudence, obstetrics, gynecology, pediatrics, chemistry, pharmacy, surgery, and medicine. The State Constitutional Convention and Legislature of 1850 were advanced by the catalogue as added

John Stough Bobbs, 1809–1870, Dean and Professor of Surgery, Indiana Central Medical College 1849–1852. Performed first cholecystostomy in the world.

inducements for acquaintances which might lead to information about desirable openings. For a degree the student must be 21 years of age, have studied medicine 3 years, completed two courses of lectures (one at least in this school), present a thesis to the Dean, and pass the final examination. The fee was 70 dollars for the full course. Board, room, fuel, and lights could be had for 2 dollars a week (6).

In his address (9) at the opening of the school, Dean Bobbs justified its organization on the ground that the State, with a million population, had too many quacks and too few graduate physicians, and that increased educational facilities would improve the status of the doctor. Discussing some of the quasi-reforms of the day urged upon the public he said:

"The chief advance in science of medicine is improved diagnosis. The chief characteristic distinguishing Empiricism from science in medicine is its contempt for diagnosis and reliance on materia medica to advance the healing art. Empiricism is labor saving and time sparing, economizes brains, and hangs the issue on the horns of chance. Thus you fish for health like a boy for eels; and when you have luck you may catch it, but it is a wet and slippery venture. Thompsonianism dispenses with any knowledge of anatomy, physical pathology, chemistry, or surgery and is a liberal indulgence of the public towards gents of small wits, who, having a repugnance to labor, mental and physical, are allowed to dispense with both in the preserving of life and health. Homeopathy was invented for the benefit of common people—those who are prone to confound change with improvement. It rests on a skillful reduction of integers to decimal fractions in potions administered. It is a considerate suspension of the laws of

nature in condescension to kid and satin, whose dainty stomachs revolt at nauseous doses, and affords a convenient way of physicking children of all ages and old women of either sex. Eclecticism omits minerals from materia medica and makes the practice of medicine simple and divested of responsibilities. Where ignorance is bliss it were folly to be wise; and when one is resolved to wear a bandage over his eyes, blindness is as good as perfect sight.

"Empiricism, Thompsonianism, Homeopathy and Eclecticism are fashionable follies of the day which, with others to come, must be met. There have always been those with audacious pretensions of ignorance who discover a more speedy and certain remedy than the usually adopted one. Medical science has nursed in her bosom the noblest specimens of humanity that have adorned the annals of man. Men of talent, education, and devotion to interest of their fellow men have found in the profession motives for their arduous and unremitting labor in its destiny to ameliorate the condition of the afflicted. These are those who have enlarged our knowledge and given fixedness and certainty to its maxims. To these we owe all that is valuable and enduring. The men who have analyzed each fluid, and patiently dissected each fibrile; elaborately explored every organ, and scrutinized every function . . . and who deduced the living truths that have given estimation and perpetuity to the science . . . after long years of arduous labor . . . they sunk into their graves, not into oblivion; but, planted deep in the firmament of the past, their names will shine out in the future, bright as the star that lights the eban brow of night. Among them, select your exemplar . . . Put in requisition the best attested means in the hands of the profession for the salvation of the patient."

The first commencement (7) was held in Wesley Chapel on Thursday, February 28, 1850, a large crowd attending. Ten degrees of M.D. were conferred by Rev. Lucien W. Berry, D.D., the President of Asbury University. Professor Harrison delivered the valedictory address, speaking on "Professional Industry." The "Indiana State Sentinal" (8) 2 weeks later, commented "that the professors were residents of a new country, yet would adorn any land, being practical men with sound heads and stores of medical information," drawing attention also to the need of more doctors of medicine, and the obvious advantage of a school in Indianapolis. Opposition had evidently been met on sectarian grounds, the "Sentinal" remarking that several of the faculty belonged to no church, that previous to the new school's birth the door was open to all, "but none others were equal to the task of originating and sustaining such a school" (8).

When the fall term for 1850 began there were 41 students, all residents of Indiana. Dr. Daniel Meeker was appointed professor of general and special anatomy. Professor Baker's name was no longer listed in the catalogue. Dr. Bobbs had assumed the chair of surgery and Dr. Deming that of special pathology and institutes of medicine. The preceptor of each student was listed, many of whom held no degree at all. During the term one D. J. Lee became the subject of some ridicule by his fellows because his preceptor was not an allopath. Fortunately for the faculty, it appeared that he had never paid his matriculation fee and was therefore dropped (10).

Professor Curran delivered the opening lecture of the second term (11).

"We are admirers of genius, but the man who can hop from the shop-board, or counter, or agricultural pursuit, or any other honest and respectable calling, and in a few short weeks penetrate the mysteries of the medical art; embracing a knowledge of anatomy, physiology, pathology, surgery, materia medica, chemistry, mental training, manipulation . . . is a prodigy that confounds, overwhelms and mystifies us. Yet there are such prodigies everywhere if we receive their testimony!—men, and women too, who seem to comprehend the wonders of the healing art by intuition, and that which renders the prodigy more prodigious is that a great multitude are foolish enough to credit such pretensions, and upon this ill bestowed and misplaced faith, live and thrive pretenders who have the audacity to claim the title of physician without ever having studied for one moment seriously upon the elements of the science . . . There is no royal road to medical learning."

During this second term a number of clinical case reports were published in the public press (12). "Bronchitis," "Operation for Clubfoot," "Operation for Artificial Iris," and "Inflammation of the Lachrymal Duct," were some of the titles. Interesting also were the theses prepared for degree, including such topics as "Pueperal Fever," "Chloroform," "Acute Rheumatism," "Normal and Abnormal Actions," "Hysteria," "Temperaments," "Vis Medicatrix Naturæ," etc.

An attempt was made in 1850 to erect a building for the school on the University Square, the Legislature authorizing the sale of an acre at an appraised price, but the appraisement was thought too high ($3566.00) for the University's means and the enterprise was abandoned (13).

February 24, 1851, the second commencement (14) was held, this time in Roberts Chapel. Twenty-one M.D.'s (three of which were honorary) were conferred by Rev. Berry. In the catalogue of 1850 (15), announcing the 1851–52 session we read:

"The Trustees having adopted sufficient measures to provide for the erection of a suitable college building, the institution is placed upon a permanent footing, and the consolidation of the Indiana Medical College, situated at La Porte, Indiana, and the Indiana Central Medical College, has transferred two eminent teachers in the former faculty to the latter and contributed many valuable additions to the means of illustration than had been previously liberally provided."

When the third and final term began in November, 1851, 41 students in attendance, only 2 names on the original faculty of 1849 appeared (16): R. S. Patterson, professor of general and special

anatomy and physiology; C. W. G. Comegys, professor of materia medica, therapeutics and medical jurisprudence; C. G. Downey, A.M., professor of chemistry and pharmacy; S. E. Leonard, professor of obstetrics and diseases of women and children; J. S. Bobbs, professor of principles and practice of surgery; E. Deming, professor of pathology and theory and practice of medicine.

The last commencement (17) was held in Wesley Chapel February 25, 1852. Sixteen degrees (including four honorary) were given by Rev. Berry. An attempt was then made to reorganize the school. The catalogue announced that "the Trustees of the University at their late meeting, permanently located the Indiana Central Medical College at Indianapolis, reorganized the Faculty and adopted efficient measures to furnish a suitable college building and other means of instruction. The institution may now be regarded as upon permanent footing"(17). How permanent was this footing? No further Asbury catalogue refers to a medical department. Frequent vacancies in the faculty had occurred, the trustees having been unable to care for it in any efficient way. The school was suspended in 1852 until sufficient funds could be raised to maintain it, and a committee appointed to take charge of the medical apparatus (18). From that time until the fall of 1869 no semblance of a medical school existed in Indiana.

To this institution go the very real distinctions of being the first medical college in the city, the first medical department of a Methodist school in the United States, and the third medical college in the State.

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15. Catalogue of Asbury University for 1850, p. 34.
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18. Minutes of the Board of Trustees, July, 1852.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE clinical experience of Bumpus and his associates in the management of common urological conditions is concisely presented in a new volume.[1] The introductory chapter on anæsthesia, the preparation of the patient, and the sterilization of instruments contains many helpful hints in proper urological technique.

Strictures of the urethra, bladder and ureteral calculi, and urethral caruncles are neatly discussed from the treatment standpoint only. Many important points in technique are illustrated by excellent drawings and photographs. The pitfalls in the management of some of these conditions are adequately stressed and pointed out.

The new treatment of prostatic hypertrophy by the transurethral route is given by Bumpus, who had had an unusual amount of interest in and experience with this procedure. He states that, in 1931, 42 per cent of their prostatic cases were treated by resection, and by the proper selection of cases an increasing number of prostatics may be treated by this new method. The larger prostates, however, should be treated by prostatectomies. As a result of their observations these authors feel that if only the obstructing tissue is adequately removed, good, uniform functional results will follow. Removing obstructive malignant prostatic tissue is frequently preferable to a permanent cystotomy tube. Contractures of the vesical neck and prostatic bars are sharply differentiated from lateral lobe prostatic enlargement, and transurethral operations are advised with the modern vision punches and resectoscopes.

In the hands of an expert like Dr. Bumpus, a minor surgical procedure (resection) for the treatment of prostatic cases has so greatly simplified the operative technique that we may now include operative risks which were formerly excluded by the open operation. However, inasmuch as prostatic enlargement is the affliction of the older man who usually has some associated cardiovascular renal disease, proper preoperative and postoperative management still remains of major importance. Should this fact be ignored in view of a simple transurethral procedure, untoward results will surely follow, particularly in the hands of the inexperienced or novice, who for some reason or other may undertake to treat obstructive uropathy.

The treatment of Bacillus coli pyelonephritis with a ketogenic diet, as worked out by Barborka, is outlined briefly with accompanying diet charts and weight tables. The management under this regimen has been found to give striking amelioration of clinical symptoms and improvement in the urinary findings.

This new urological volume is an asset to any medical library and an excellent reference for the specialist.

L. W. RIBA.

A CONCISE and practical manual[2] on cancer has been prepared by Mandl. His intention to present a brief compend which would cover the essentials of the theory and practice as well as the treatment of malignant disease has been fulfilled. Much of the material is drawn from the clinic of Hochenegg.

The first portion of the work is devoted to a general consideration of malignant disease. The various theories of the causation of cancer are discussed and the conclusion is reached that factors other than those advanced to date must obtain. In the discussion of the symptoms and diagnosis, the author stresses the importance of immediate radical operation after biopsy on the premise that the procedure stimulates activity in the malignant growth. After reviewing the various specific tests for malignant disease, the author states that the clinical history, general examination with modern methods of special examination such as with biopsy and with the roentgen ray, the endoscope and the like, are the only reliable means at hand today with which to make a correct diagnosis. Surgical exploration for deep seated carcinoma is often necessary. A short but extremely interesting description is given of the various forms of treatment. Surgical removal, radiation therapy, toxin and serum therapy, the use of ferments, metals, and dyes are discussed in a general way. Mandl is of the opinion that in specific instances, radiation therapy is the treatment of choice, but that in general the surgical removal with the judicious use of radiation, either radium or the roentgen ray, offers the best and only reliable form of therapeutic approach.

The second portion of the book is devoted to malignant disease of special parts or organs. The

[1] MAYO CLINIC MONOGRAPHS. MINOR SURGERY OF THE URINARY TRACT. By Hermon C. Bumpus, Jr., Ph.B., M.D., M.S., F.A.C.S. With a chapter on Caruncles by John L. Crenshaw, M.D., and a chapter on Postoperative Care by Anson L. Clark, M.E., M.D. Philadelphia and London: W. B. Saunders Company, 1932.

[2] THEORIE UND PRAXIS DER KREBSKRANKHEIT. By Privatdozent Dr. Felix Mandl. Vienna: Wilhelm Maudrich, 1932.

author presents a brief but lucid description of the disease as it affects the various organs, including the forms of growth, the symptoms, differential diagnosis, and the treatment which in his experience has yielded the best results. At the close of the description for each region, statistics from other large clinics are quoted.

For a small compend of 144 pages, this little work incorporates an enormous amount of valuable information which is shorn of all verbosity. For the student of medicine, the general practitioner, even the student of malignant disease, this work is invaluable since in such a concise form there is available so much useful information. The conclusions are well drawn and the author clings to the accepted form and is not beguiled by phantasy or will-o'-the-wisps.

J. A. WOLFER.

THE book by Straub on *Surgery of the Chest*[1] presents, in 474 pages, a brief survey of the field of thoracic surgery. The sections on normal and pathological thoracic physiology and on the general principles and technique of thoracic operations are succinct and excellent. They are obviously based upon a wide personal experience and a thorough familiarity with the literature. The many illustrations, most of them sketches and diagrams by the author, evince a skill in this field not short of professional. They compare favorably with those done by Graves for his textbook on *Gynecology*, not only in their execution but in the aptness with which they supplement the text. As a brief text on the operative surgery of the thorax, the book is decidedly valuable.

In any branch of surgery, which is undergoing rapid evolution, experiment is rife and obsolesence rapid. This is true of thoracic surgery at the present time. While in the past 50 years many principles and procedures have become finally established, there are many others the value of which is uncertain. To expect an author to do what time alone can do, to judge and choose between these, is to expect the impossible. In most instances, the therapy recommended is safe and tried, and the selection and evaluation of procedures is carefuly done.

I have said that this is an excellent brief text on the operative surgery of the thorax. The chief problems of thoracic surgery are not operative. They concern themselves with diagnosis and with indications. The sections of the book which deal with these phases are too brief and present dogmatically too many disputed questions to be satisfactory.

Criticisms of the book might be many but these would be partly matters of variations of opinions and wholly criticisms of the present status of thoracic surgery. Personally, I cannot agree with the author that phrenico-exeresis has little value save as an accessory procedure, nor do I feel that experience with cautery lobectomy has justified its further use. Thoracoplasty is recommended for bronchiectasis yet the results from this procedure in this disease are scarcely commensurate with the risks and the deformity. I could continue mentioning differences of opinion. In general, I feel that a very unsettled and uncertain field has been dealt with too briefly to give a just conception of the problems daily encountered as to indications.

J. H.

[1] SURGERY OF THE CHEST. By George F. Straub, M.D., F.A.C.S., Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1932.

HUDDLESON has given us a most valuable and timely book.[2] Its thoughtful study by all who have to do with compensable injuries should work mightily in the prophylaxis of traumatic neuroses. The happiness and usefulness of thousands of patients and the expenditure of many millions of dollars are closely concerned with enlightenment of the physician who first attends the injured and with the manner in which compensation is awarded. As Huddleson says (page 180), "In any community, the sooner the economic and psychologic influence of compensation is terminated, the better for all concerned. Most effective is the promptest possible lump sum award, or denial of award, by an authority from which there is no appeal. So long as a traumatic neurotic has a law suit pending, so long as he continues to be a claimant for compensation, he is practically incurable."

The book is very readable. It contains abundant valuable references to the literature and numerous interesting case reports. The reviewer most emphatically endorses its importance not only to all medical men concerned with industrial work but also to compensation boards and legislators.

FREDERICK CHRISTOPHER.

SEEMEN[3] has presented an exceedingly valuable contribution to the subject of electrosurgery in his new book. In the judgment of the reviewer it presents the most complete bibliography and review of the literature on the subject of electrosurgery thus far prepared by any author. From the historical standpoint, Seemen has developed a logical sequence from the century-old use of the hot iron, through the period of the cautery to the present day of electrocoagulation.

In talking or writing on electrosurgery, various authors employ such terms as surgical diathermy, endothermy, radio knife, etc. Under electrosurgery this author has adopted the terms, electrodesiccation, electrocoagulation, and electromie. He recommends the latter term as designating the electrical cutting current. Even this comprehensive book on this subject shows the need for developing an international nomenclature applicable to all forms of electrosurgery. Seemen gives a very complete description of the various electrical currents used in electrosurgery and makes valuable sug-

[2] ACCIDENTS, NEUROSES AND COMPENSATION. By James H. Huddleson, M.D. With a Foreword by J. Ramsay Hunt, M.D., Sc.D. Baltimore: The Williams & Wilkins Company, 1932.

[3] ALLGEMEINE UND SPEZIELLE ELEKTROCHIRURGIE. By Dr. med. Hans v. Seemen. With a chapter on Elektrochirurgie der Geschwülste in Verbindung mit Strahlenbehandlung by Dr. med. Otto Schürch. Berlin: Julius Springer, 1932.

gestions as to the various instruments to be used in connection with it. The different machines developing the currents which he describes are chiefly of the German make.

The chapter on histology contains beautiful illustrations and complete descriptions of tissue studies which have been made following the use of the electric current. These studies refute the claim of many of our pathologists to the effect that the electric surgical currents so destroy the tissue removed at biopsy that histological study is impossible.

In the section on "Special Electrosurgery" the author opens up a wide vista of usefulness for electrosurgery. As practiced by most surgeons in this country, electrosurgery has been restricted largely to malignancies. Dr. von Seemen has used it in amputations, in infections, especially carbuncles, in osteomyelitis, in gastro-intestinal surgery of non-malignant nature, and in several other conditions. This author's description and illustrations of large numbers of cases of carcinoma and sarcoma, of the lips, oral cavity, the eye, ear, and other parts of the head, furnishes extremely convincing proof that electrosurgery offers real hope in many cases of heretofore called inoperable malignancy. The plastic operations described throughout the book to overcome severe deformities, especially about the face, remaining after the removal of a malignant growth by electrosurgery, makes this publication a fairly valuable one from the standpoint of the man doing plastic surgery.

Dr. Schuerch, Zurich, has a chapter in this volume which details several very advanced cases of carcinoma and sarcoma, of the face, oral cavity, and of the rectum, wherein he uses a combination of electrosurgery and radium.

A criticism of the book might be offered in that more emphasis might have been given to the use of electrosurgery in removing carcinoma of the breast, in performing a thyroidectomy, and in doing brain surgery. On the whole, the volume is a real contribution to the field of electrosurgery.

HARRY E. MOCK.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

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